

**Roads2HyCom**

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**“European Hydrogen Infrastructure Atlas” and  
“Industrial Excess Hydrogen Analysis”**

**PART II: Industrial surplus hydrogen and markets and production**

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The European Commission is supporting the Coordination Action “HyLights” and the Integrated Project “Roads2HyCom” in the field of Hydrogen and Fuel Cells. The two projects support the Commission in the monitoring and coordination of ongoing activities of the HFP, and provide input to the HFP for the planning and preparation of future research and demonstration activities within an integrated EU strategy.

The two projects are complementary and are working in close coordination. HyLights focuses on the preparation of the large scale demonstration for transport applications, while Roads2HyCom focuses on identifying opportunities for research activities relative to the needs of industrial stakeholders and Hydrogen Communities that could contribute to the early adoption of hydrogen as a universal energy vector.

Further information on the projects and their partners is available on the project web-sites [www.roads2hy.com](http://www.roads2hy.com) and [www.hylights.org](http://www.hylights.org)

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## ABSTRACT

Many industrial processes require hydrogen as an ingredient, or produce hydrogen as a by-product. Surplus hydrogen from these industrial processes could be used to fuel both transport and stationary applications during the transition phase towards a hydrogen economy. The main three players in the hydrogen market are merchant companies (which trade hydrogen), captive producers (which produce hydrogen for their direct customer or their own use), and by-product hydrogen producers (which provide hydrogen resulting from chemical processes). Total hydrogen consumption in Western Europe is estimated to be about 61bn m<sup>3</sup> (2003), 80% of which was consumed by mainly two industrial sectors: the refinery (50%) and the ammonia industry (32%), which are both captive users. If one adds hydrogen consumption by methanol and metal industries, those four sectors cover 90% of the total consumption. Total European production is estimated at about 90bn m<sup>3</sup>: 80bn m<sup>3</sup> for European Union members (including 22bn m<sup>3</sup> for Germany, 10bn m<sup>3</sup> for the Netherlands, and about 5-7bn m<sup>3</sup> for both the United Kingdom, France, Italy, Spain and Belgium), 2bn m<sup>3</sup> for EFTA countries, and 10bn m<sup>3</sup> for Candidate Countries (CC). Broken down to market sectors the captive industry produces around 64% of the total, followed by the by-products industry (27%) and merchant companies (9%). The geographic distribution of all identified hydrogen production sites is shown on an aggregated level for further analysis of production sites in the context of future large-scale demonstration projects where the distance from production to use will be of importance. It can already be seen that there are clusters of production, mainly in the Benelux and Rhein-Main area as well as in the Midlands and North Italy. By-product hydrogen production, i.e. hydrogen produced inadvertently as a by-product of a chemical process, is estimated to be 23bn m<sup>3</sup> per year with Germany (6.8 bn m<sup>3</sup>) and the United Kingdom (3.6 bn m<sup>3</sup>) being the largest producers. In the report, detailed figures for the hydrogen production and the by-product occurrence in different industries are shown. Analysing the different excess margin scenarios it appears that a potential of 2-10bn m<sup>3</sup> hydrogen might be available as "surplus hydrogen" in Europe, either in the form of excess capacity (0-5bn m<sup>3</sup>) or by-product hydrogen (2-5bn m<sup>3</sup>). This surplus volume is far from negligible: with 2-10bn m<sup>3</sup> hydrogen it is possible to supply about 1-6 million vehicles. That number, though, represents only 1.5-3% of all vehicles in the EU (estimated at 190m). Surplus hydrogen can hence be considered as a potential hydrogen source for the transition phase only.

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# EUROPEAN HYDROGEN INFRASTRUCTURE ATLAS

## PART II: INDUSTRIAL SURPLUS HYDROGEN AND MARKETS AND PRODUCTION

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# 1. Introduction

Many industrial processes require hydrogen as an ingredient or produce hydrogen as a by-product. Surplus hydrogen from these industrial processes could be used to fuel both transport and stationary applications during the transition phase towards a hydrogen economy. One of the subtasks of the EU project Roads2HyCom is to sketch a picture of the industrial surplus of hydrogen in Europe. During the first year of the Roads2HyCom project, data on surplus hydrogen has been collated as part of a mapping exercise on hydrogen infrastructure in Europe. This report presents the results from analysing the data on industrial surplus hydrogen.

Industrial surplus hydrogen is defined as:

- **production margin (capacity minus demand):** available hydrogen from captive users like refineries or ammonia industries; installed capacities may exceed internal consumption, thus resulting in potential excess of hydrogen.
- **waste by-product hydrogen:** available hydrogen from chemical industries (e.g. chlorine production) and **not used** for other chemical process, not used as an energy source (fuel for heating processes), and not sold to a merchant company.
- **valorised by-product hydrogen:** by-product hydrogen from chemical industries which is valorised, meaning upgraded in its value. This applies to hydrogen which is normally used as an energy source (as fuel burnt for heating processes), but is then substituted by other energy sources (eg natural gas) and can be used for higher value processes like transport fuel (*examples of by-product valorisation are given in annex 3.*

Hydrogen quality and available infrastructure (pipelines etc.) are also two important factors for estimating the real potential of industrial surplus hydrogen. Infrastructure will be further investigated in part III of this Roads2HyCom report.

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Captive users:	mostly industrial gas companies that produce on-site at a customer exclusively for this customer, e.g. refineries, ammonia and methanol industry
By-product:	hydrogen that is produced inadvertently as a by-product of a (chemical) process, e.g. production of chlorine, ethylene, acetylene, cyanide, styrene etc.
Merchants:	companies that trade with hydrogen; sometimes producing the hydrogen themselves, sometimes not and only trading, sometimes both

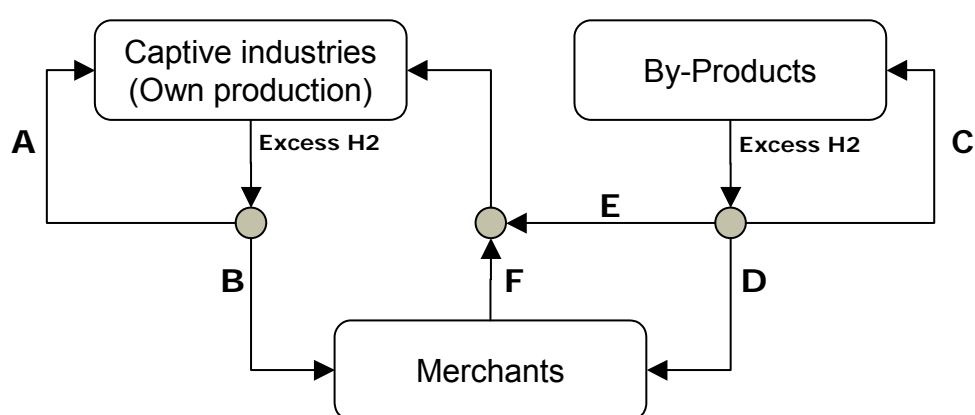
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## 2. Overview of the European market

### 2.1 Market structure

The hydrogen market comprises three main players: merchant companies which trade hydrogen, captive producers which produce hydrogen for their direct customer or their own use and by-product hydrogen resulting from chemical processes. The links between them can be summarized by the following graph:



**Figure 1: Hydrogen Market Structure**

*Captive industry: excess hydrogen, if existing, can be used by other captive companies (A) or be sold to merchants (B);*

*By-product hydrogen: resulting hydrogen can be used for internal needs for a chemical process or as energy carrier (C), be sold to merchants (D) or be sold directly to the captive industry (E);*

*Merchants: hydrogen bought from captive (B) or by-products industries (D) is sold to other captive companies (F) and to specific industries. (merchants can also act as producer for a specific site).*



## Western European consumption

The entire western European hydrogen consumption was estimated by SRI CONSULTING (2004) to be about 61bn m<sup>3</sup> in 2003, with a forecast of 76bn m<sup>3</sup> in 2008 (world total was around 450bn m<sup>3</sup> in 2003, including 84bn m<sup>3</sup> for the United States). In Europe, 80% of the total hydrogen was consumed by mainly two industrial sectors: the refinery (50%) and the ammonia industry (32%), which are both captive users. If one adds hydrogen consumption by methanol and metal industries, those four sectors cover 90% of the total.

## Refinery industries

Hydrogen is used mainly for hydro-cracking and hydro-treating de-sulphurisation units. Some of the hydrogen is produced internally as by-product from catalytic cracking in the catalytic reforming units. If necessary, steam methane reformers can also be installed to supply the needed hydrogen. As one can expect both harder regulations for products with regard to sulphur as well as an increasing level of sulphur in raw products, hydrogen consumption is going to grow rapidly during the next years. SRI estimated an 8% annual growth rate between 2003 and 2008. In this context, surplus hydrogen sold to merchant companies in the past could be limited in the future. It is generally estimated that refineries will be net hydrogen consumers.

## Ammonia industry

Ammonia industry is the largest hydrogen consumer in the chemical industry with around 20bn m<sup>3</sup> compared to 3bn m<sup>3</sup> for the methanol sector. SRI estimated that, after a huge decline during the last ten years (28bn m<sup>3</sup> in 1990), hydrogen consumption will remain constant up to 2008.



**Table 1: Hydrogen consumed by major production processes in Western Europe  
(Source: SRI Consulting 2004)**

	Consumption [bn m <sup>3</sup> ]		Growth rate [%/year]	Share of total [%]	
	2003	2008 extrapolation		2003	2008 extrapolation
Refining	30.56	44.74	7.9	49.7	58.6
Ammonia	19.44	19.50	0.1	31.6	25.5
Methanol	3.36	3.10	-1.6	5.5	4.1
Metals	2.67	3.25	4.0	4.3	4.3
Cyclohexane	1.01	1.11	1.9	1.6	1.5
Aniline	0.95	1.05	2.0	1.5	1.4
Caprolactam	0.71	0.75	1.0	1.2	1.0
H <sub>2</sub> Peroxide	0.70	0.75	1.2	1.1	1.0
Oxo Alcohols C8	0.34	0.35	0.6	0.6	0.5
Oxo Alcohols C4	0.26	0.27	0.7	0.4	0.4
Toluene Diisocyanate	0.38	0.35	-1.6	0.6	0.5
Hexamethylenediamine	0.31	0.33	1.6	0.5	0.4
Adipic Acid	0.15	0.16	0.8	0.3	0.2
Hydrochloric acid	0.10	0.10	-0.4	0.2	0.1
Tetrahydrofuran	0.21	0.22	1.6	0.3	0.3
Fats and oils	0.31	0.30	-0.3	0.5	0.4
Float glass	0.04	0.05	3.4	0.1	0.1
Electronics	0.03	0.04	2.3	0.1	0.0
<b>Total</b>	<b>61.53</b>	<b>76.41</b>	<b>4.4</b>	<b>100</b>	<b>100</b>

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### 3. Hydrogen sources

#### 3.1 European hydrogen production

Based on the Roads2HyCom analysis, total European production is estimated at about 90bn m<sup>3</sup> (see table 3):

- 80bn m<sup>3</sup> for European Union members, including 22bn m<sup>3</sup> for Germany, 10bn m<sup>3</sup> for the Netherlands, and about 5-7bn m<sup>3</sup> for both the United Kingdom, France, Italy, Spain and Belgium.
- 2bn m<sup>3</sup> for EFTA countries;
- 10bn m<sup>3</sup> for Candidate Countries (CC).

Differences to the previously mentioned *SRI* study (ca. 70bn m<sup>3</sup> in 2005 for EU and EFTA countries) can be explained by the fact that Roads2HyCom has estimated the production capacity for some players, particularly for the captive industry (ammonia, methanol). For by-products sources (ethylene, acetylene, styrene, cokeoven gas), hydrogen production was calculated with a pre-set ratio (hydrogen produced per ton of chemical product). It therefore needs to be mentioned that the figure of 10bn m<sup>3</sup> more available surplus carries a certain risk and a more precise site-by-site analysis is needed to put these numbers on firm ground.

Analysis by market sectors shows that the captive industry produces around 64% of the total, followed by the by-products industry (27%) and merchant companies (9%) (see table 2).

**Table 2: Hydrogen production by market sector [bn m<sup>3</sup>/year]**

Market sector	H <sub>2</sub> production
By-Product	23
Captive	57
Merchant	8
<b>Total</b>	<b>88</b>

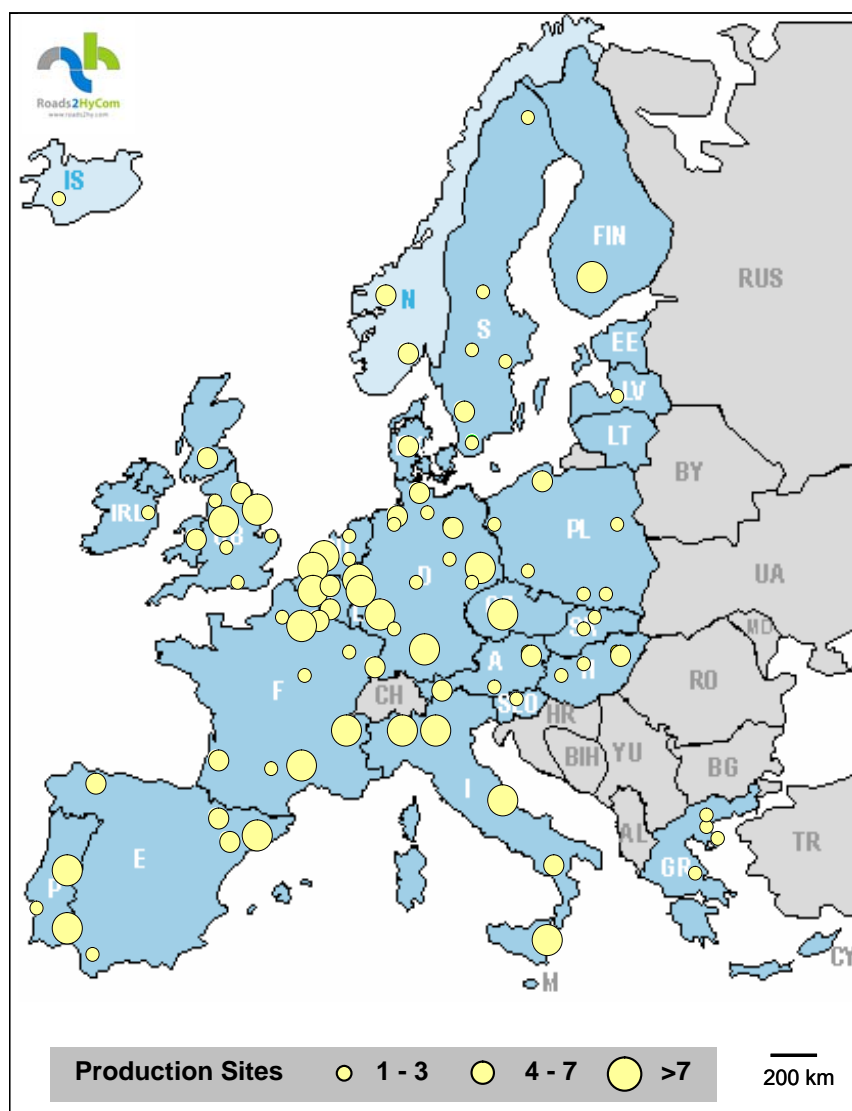


**Table 3: Hydrogen production by zone and country. See annex 1 and 2 for more detailed data per region.**

Zone	Country	bn m <sup>3</sup>
EU 25	Austria - Österreich	1.9
	Belgium - Belgique - België	5.7
	Czech Republic -Ceska Republika	0.9
	Denmark - Danmark	0.2
	Finland - Suomi	1.8
	France	7.1
	Germany - Deutschland	21.5
	Greece - Ellada	0.8
	Hungary - Magyarorszag	1.0
	Ireland	0.9
	Italy - Italia	6.6
	Lithuania - Lietuva	0.6
	Netherlands - Nederland	10.1
	Poland - Polska	4.2
	Portugal	1.2
	Slovakia - Slovenska Republika	0.9
	Slovenia - Slovenija	0.0
	Spain - España	5.9
Sweden - Sverige	1.3	
United Kingdom	7.6	
	Total EU 25	80.3
CC	Bulgaria	1.8
	Croatia - Hrvatska	0.8
	Romania	5.5
	Turkey - Turkiye	2.2
	Total CC	10.2
EFTA	Iceland - Ísland	0.0
	Norway - Norge	1.0
	Switzerland - Schweiz - Suisse - Svizerra	0.6
	Total EFTA	1.6
<b>Total</b>		<b>92.1</b>



The geographic distribution of all identified hydrogen production sites can be found on an aggregated level in figure 2. This overview is necessary for further analysis of production sites in the context of future large-scale demonstration projects where the distance from production to use will be of importance. It can already be seen that there are clusters of production, mainly in the Benelux and Rhein-Main area as well as in the Midlands and North Italy.



**Figure 2: Geographic distribution of identified industrial hydrogen production facilities. It can already be seen that there are clusters of production, mainly in the Benelux and Rhein-Main area as well as in the Midlands and North Italy.**



### 3.2 Focus on by-product hydrogen

By-product hydrogen, i.e. hydrogen produced inadvertently as a by-product of a chemical process, is estimated to be 23bn m<sup>3</sup> per year, including 21bn m<sup>3</sup> for 7 countries, figure 3 showing the estimation per country in a pie-chart.

- Germany: 6.8 bn m<sup>3</sup>
- United Kingdom: 3.6 bn m<sup>3</sup>
- Netherlands: 2.5 bn m<sup>3</sup>
- Spain: 2.2 bn m<sup>3</sup>
- France: 2.2 bn m<sup>3</sup>
- Belgium: 1.7 bn m<sup>3</sup>
- Italy: 1.6 bn m<sup>3</sup>

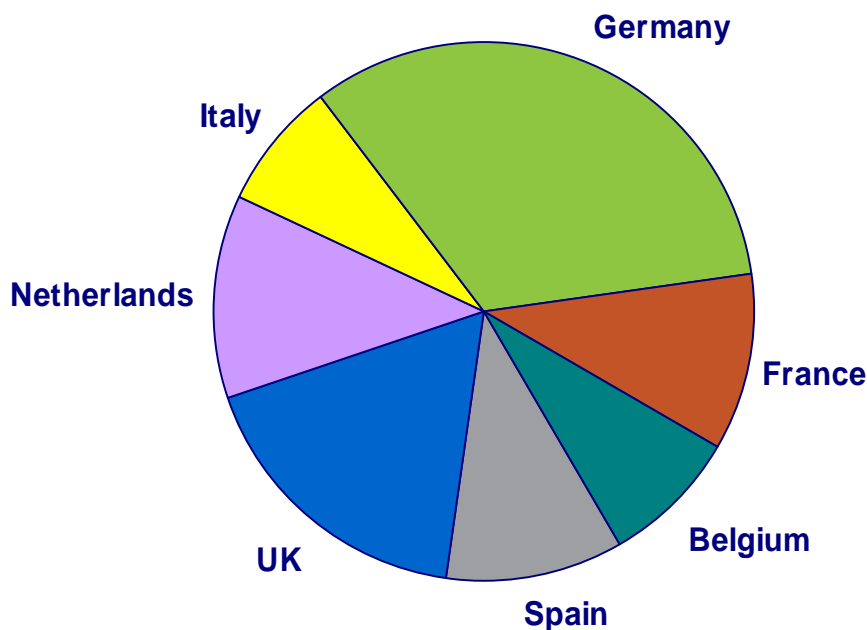


Figure 3: By-product hydrogen estimations per country (only seven largest producer)



It should be noted that some projects using by-product hydrogen are under development in several countries, particularly: the Netherlands (PemPowerPlant), Norway (Hynor), Italy (Hydrogen Park), the United States (GM & Dow), Canada (IWHUP) and Japan (JHFC) (see also annex 3).

By-product hydrogen is generally either used as a chemical component for downstream processes or as fuel to produce heat. The two main alternative uses would be:

- **Internal use** with fuel cells to produce electricity in order to reduce energy consumption (economic feasibility depends on electricity prices)
- **External use** to supply vehicles via a hydrogen station (if a pipeline network is available)

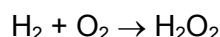


### 3.3 Hydrogen production in different industries

The most common method for large hydrogen consumers is on-site production of hydrogen at the consumption site. This is mainly done for refineries, fertilizer plants (ammonia), methanol, and hydrogen peroxide production plants.

#### Hydrogen peroxide:

H<sub>2</sub>O<sub>2</sub> production usually is according to the following process:



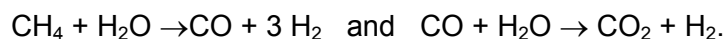
This results in a theoretical specific hydrogen need of about 735 m<sup>3</sup> H<sub>2</sub>/t H<sub>2</sub>O<sub>2</sub>.

#### Methanol peroxide:

Methanol is produced by different paths where the final reaction results in



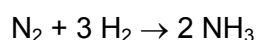
The most common production method is steam reforming of methane and subsequent methanol synthesis. This process, when properly adjusted, produces the hydrogen demand internally from the methane decomposition according to:



Other processes e.g. from coal or oil decomposition result in an external hydrogen demand. Only taking into account the final step of the reaction, this production consumes about 1400 m<sup>3</sup> H<sub>2</sub>/t of methanol.

#### Fertilizer production:

Hydrogen is used for ammonia production according to the following formula:



This production consumes about 1975 m<sup>3</sup> H<sub>2</sub>/t ammonia.

#### Refineries:

Refineries not only consume, but also produce hydrogen at different stages of cracking and reformulating crude oil:

- during thermal cracking hydrogen is produced at a rate of 3 m<sup>3</sup> H<sub>2</sub>/t crude oil
- during catalytic cracking hydrogen is produced at a rate of 100 m<sup>3</sup> H<sub>2</sub>/t crude oil
- during catalytic reformulation hydrogen is produced at a rate of 200 m<sup>3</sup> H<sub>2</sub>/t crude oil



However, all these processes allow hydrogen production only at a very limited purification degree of between 70-80%. Therefore, for further use of hydrogen (other than generation of process heat) a purification process by PSA or membrane is needed which may purify the hydrogen to a concentration higher than 99%.

Finally, to a small amount, hydrogen is produced as by-product of coke production at a small production rate of 35 m<sup>3</sup> H<sub>2</sub>/t.

On the **consumption** side hydrogen is needed in several processing units for cracking benzines and treating gasoline and distillates with the following demand:

- hydrogen consumption for hydrocracking amounts to 300 m<sup>3</sup> H<sub>2</sub>/t of product
- hydrogen consumption for catalytic cracking amounts to 80 m<sup>3</sup> H<sub>2</sub>/t of product
- hydrogen consumption for hydration of cokers amounts to 50 m<sup>3</sup> H<sub>2</sub>/t of product
- gasoline hydrotreating amounts to 20 m<sup>3</sup> H<sub>2</sub>/t of product
- distillates hydrotreating amounts to 35 m<sup>3</sup> H<sub>2</sub>/t of product

The hydrogen net balance of a refinery strongly depends on the processes involved and products generated. Therefore, it may change greatly from refinery to refinery and cannot be calculated from the production volumes alone, but additional information on process characteristics is needed.

For use in hydro crackers, high purity hydrogen is needed. This hydrogen is often produced from steam reformers. Also, the increasing efforts in desulfurisation increase the hydrogen demand of a refinery and make on-site construction of steam reformers necessary.



### 3.4 By-product occurrence in different industries

#### Chlorine production (with high purity)

Hydrogen comes as by-product during chlorine electrolysis according to the following process:



This results in typical hydrogen production volumes of 300 m<sup>3</sup> H<sub>2</sub>/t chlorine, which may come down to 270 m<sup>3</sup> H<sub>2</sub>/t chlorine in state-of-the-art electrolyzers.

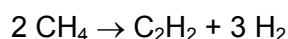
#### Ethylene production (about 80% hydrogen content)

Ethylene production is both a consumer of hydrogen as well as a producer of hydrogen depending on the process step. Hydrogen is usually produced at a rate of 370 m<sup>3</sup> H<sub>2</sub>/t ethylene and consumed at a later stage at a rate of 180 m<sup>3</sup> H<sub>2</sub>/t ethylene. Therefore, a net production rate of about 190 m<sup>3</sup> H<sub>2</sub>/t ethylene remains.

#### Acetylene production

There are several production methods of acetylene, either from hydrocarbons or from calcium carbide. The destruction of hydrocarbons itself allows several different process steps with different amounts of hydrogen. The two most important processes that yield hydrogen are:

- Partial oxidation (BASF or Sachsse process) which works according to

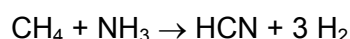


- Electric arc decomposition of the hydrocarbons.

Hydrogen is produced as by-product in both processes where according to the production method between 3,400 m<sup>3</sup> H<sub>2</sub>/t (arc process) and 3,740 m<sup>3</sup> H<sub>2</sub>/t (Sachsse-process) are produced.

#### Cyanide production (about 95% hydrogen with methane and nitride content)

Hydrogen cyanide is manufactured either by direct production or as co-product. Its production through the often used Andrussov process doesn't involve hydrogen as a by-product. Only Degussa's BMA (blausauer, methane, ammonia) process results in pure hydrogen as a by-product according to:



The industrial production rate of hydrogen in that process is about 2,470 m<sup>3</sup> H<sub>2</sub>/t of blausauer.



### **Styrene production, Coke Oven Plants**

Hydrogen occurs also as by-product from styrene production with a specific production rate of 220 m<sup>3</sup> H<sub>2</sub>/t of styrene; for cokeoven production this ratio is about 450 m<sup>3</sup> H<sub>2</sub>/t of product.

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## 4. Industrial surplus hydrogen

### 4.1 Previous study

In 1999, LBST conducted an enquiry to estimate excess hydrogen and production extension in Europe (LUDWIG-BÖLKOW-SYSTEMTECHNIK 1999). Sectors analysed were the following: ammonia, refineries, hydrogen peroxide, methanol, chlorine, ethylene, acetylene, hydrogen cyanide, styrene, representing 50bn m<sup>3</sup> (without methanol and hydrogen peroxide). Responses received cover around 35% of the market (17.4bn m<sup>3</sup> compared to a total market estimated at 48.9bn m<sup>3</sup>).

The study shows that about 0.4bn m<sup>3</sup> (3% of the confirmed 17.4bn m<sup>3</sup> hydrogen) can be considered as excess/extension and 1bn m<sup>3</sup> (6% of the same market) could be substituted with natural gas (see table 4). Excess was identified in the Netherlands, Belgium and France, and a potential for substitution in Germany.

If we apply these ratios (3/6%) to the total hydrogen market (ca. 90bn m<sup>3</sup>), excess and substitution could represent a little more than 8bn m<sup>3</sup> (2.7bn or 5.4bn m<sup>3</sup> respectively). These estimations need certainly some verification by a separate study.

**Table 4: Substitution and surplus/extension potential of hydrogen by country. The figures represent only 35% of the estimated total market. (LUDWIG-BÖLKOW-SYSTEMTECHNIK 1999).**

	Production Sites		Estimated Production [bn m <sup>3</sup> H <sub>2</sub> ]	Confirmed production [bn m <sup>3</sup> H <sub>2</sub> ]	Extension/ Surplus [bn m <sup>3</sup> H <sub>2</sub> ]	H <sub>2</sub> substitutable with NG [bn m <sup>3</sup> H <sub>2</sub> ]
		With Surplus				
Austria	3	0	1.07	0.00		
Belgium	11	1	1.89	0.95	0.10	0.01
Denmark	0	0				
Finland	8	1	3.73	0.71	0.00	
France	20	1	4.98	2.04	0.10	0.04
Germany	41	10	18.49	8.65	0.03	0.98
Greece	5	0	0.09	0.06		0.03
Iceland	1	0	0.02	0.02		
Ireland	2	0	0.79	0.00		
Italy	27	0	3.29	0.22		
Luxemburg	1	0		0.00		
Netherlands	11	2	6.89	1.00	0.14	
Portugal	4	0	1.49	0.88		0.06
Spain	18	4	1.90	1.16	0.02	
Sweden	9	4	0.35	0.25	0.05	
United Kingdom	15	0	3.88	1.53		
<b>Total</b>	<b>176</b>	<b>23</b>	<b>48.9</b>	<b>17.4</b>	<b>0.44</b>	<b>1.11</b>



The very low excess hydrogen in this study can be explained by the fact that:

- 1) hydrogen producers (refiners, ammonia...) adapt their production to their needs (refiners particularly need more and more hydrogen, and surplus for this industry is probably limited or zero; ammonia production is now relatively stable in Europe, meaning constant use of Hydrogen and capacities adapted to internal needs).
- 2) local trade of hydrogen between captive and chemical industries facilitate the valorisation of surplus which is then not available any longer
- 3) merchant companies also try to valorise market availabilities: in this context, existing surplus is probably still bought by those companies.



## 4.2 Qualitative approaches

Potential surplus hydrogen, which could be used in the transition hydrogen phase, can be expected in two forms:

- excess capacity (from captive industries)
- by-product hydrogen (as waste or from NG substitution).

### Excess capacity from captive producers

Excess capacity from captive producers (mainly refiners or ammonia industry) is probably very low. Refiners need more and more hydrogen, and capacity is adapted to their needs. Nevertheless it is probable that a capacity margin exists as in other industries. A 10% margin is believed to be a reasonable estimate, meaning some 3bn m<sup>3</sup> hydrogen as surplus (based on the consumption of 30bn m<sup>3</sup>).

Considering that ammonia production is now stagnating in Europe, it is probable that production is adapted to consumption. If one still applies a 10% margin like in the refinery sector, available volumes are in the range of about 2bn m<sup>3</sup> hydrogen (based on the consumption of 20bn m<sup>3</sup>).

In total, excess capacity from captive producers could be in the range of 0-5bn m<sup>3</sup> hydrogen.

### By-product hydrogen

For the calculation of surplus hydrogen from by-products a ratio of 10-20% was taken, the assumption being that only 10-20% is available as an excess margin and the rest being used in other chemical processes and therefore not available. If this ratio is applied to the current by-product production of 23bn m<sup>3</sup> this potential could reach a total volume of 2-5bn m<sup>3</sup> of surplus hydrogen.



In summary, based on this qualitative approach, the potential amount of surplus hydrogen could be about 2-10bn m<sup>3</sup> including 0-5bn m<sup>3</sup> from excess capacities and 2-5bn m<sup>3</sup> from by-product occurrence. Per country the distribution is as follows:

- Germany: 0.7 - 2.7 bn m<sup>3</sup>
- Netherlands: 0.2 - 1.2 bn m<sup>3</sup>
- United Kingdom: 0.4 - 1.0 bn m<sup>3</sup>
- France: 0.2 - 0.8 bn m<sup>3</sup>
- Spain/Italy: 0.2 - 0.7 bn m<sup>3</sup>
- Belgium: 0.2 - 0.6 bn m<sup>3</sup>
- Romania: 0.0 - 0.6 bn m<sup>3</sup>
- Poland: 0.0 - 0.4 bn m<sup>3</sup>
- Austria: 0.1 - 0.3 bn m<sup>3</sup>
- Sweden/Bulgaria: 0.0 - 0.2 bn m<sup>3</sup>
- Czech / Greece / Ireland: 0.0 - 0.2 bn m<sup>3</sup>

Although these figures may not be exact, they still give a good view of the potential by country and region. The detailed composition of the above figures are presented in table 5.



**Table 5: Potential amount of surplus hydrogen by country based on a qualitative approach [bn m<sup>3</sup> H<sub>2</sub>].**

	By-product industry			Captive industry		Total Surplus	
	Total production	Surplus two margin scenarios		Total production	Surplus one margin scenario		
		10%	20%			10%	Min
Austria	0.72	0.07	0.14	1.15	0.11	0.07	0.26
Belgium	1.74	0.17	0.35	2.23	0.22	0.17	0.57
Bulgaria	0.00	0.00	0.00	1.68	0.17	0.00	0.17
Czech Republic	0.04	0.00	0.01	0.91	0.09	0.00	0.10
Denmark	0.00	0.00	0.00	0.17	0.02	0.00	0.02
Finland	0.55	0.05	0.11	1.21	0.12	0.05	0.23
France	2.23	0.22	0.45	3.78	0.38	0.22	0.83
Germany	6.79	0.68	1.36	12.78	1.28	0.68	2.64
Greece	0.01	0.00	0.00	0.74	0.07	0.00	0.08
Hungary	0.04	0.00	0.01	0.95	0.09	0.00	0.10
Iceland	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.91	0.09	0.00	0.09
Italy	1.64	0.16	0.33	3.88	0.39	0.16	0.72
Lithuania	0.00	0.00	0.00	0.64	0.06	0.00	0.06
Netherlands	2.51	0.25	0.50	6.87	0.69	0.25	1.19
Norway	0.20	0.02	0.04	0.78	0.08	0.02	0.12
Poland	0.05	0.01	0.01	4.09	0.41	0.01	0.42
Portugal	0.11	0.01	0.02	1.05	0.11	0.01	0.13
Romania	0.09	0.01	0.02	5.30	0.53	0.01	0.55
Slovakia	0.02	0.00	0.00	0.91	0.09	0.00	0.10
Spain	2.22	0.22	0.44	2.91	0.29	0.22	0.73
Sweden	0.78	0.08	0.16	0.56	0.06	0.08	0.21
Switzerland	0.04	0.00	0.01	0.51	0.05	0.00	0.06
UK	3.59	0.36	0.72	3.54	0.35	0.36	1.07
<b>Total</b>	<b>23.36</b>	<b>2.34</b>	<b>4.67</b>	<b>57.58</b>	<b>5.76</b>	<b>2.34</b>	<b>10.43</b>



The difference between this calculation and previous studies (as mentioned in section 4.1.) is shown in figure 4.

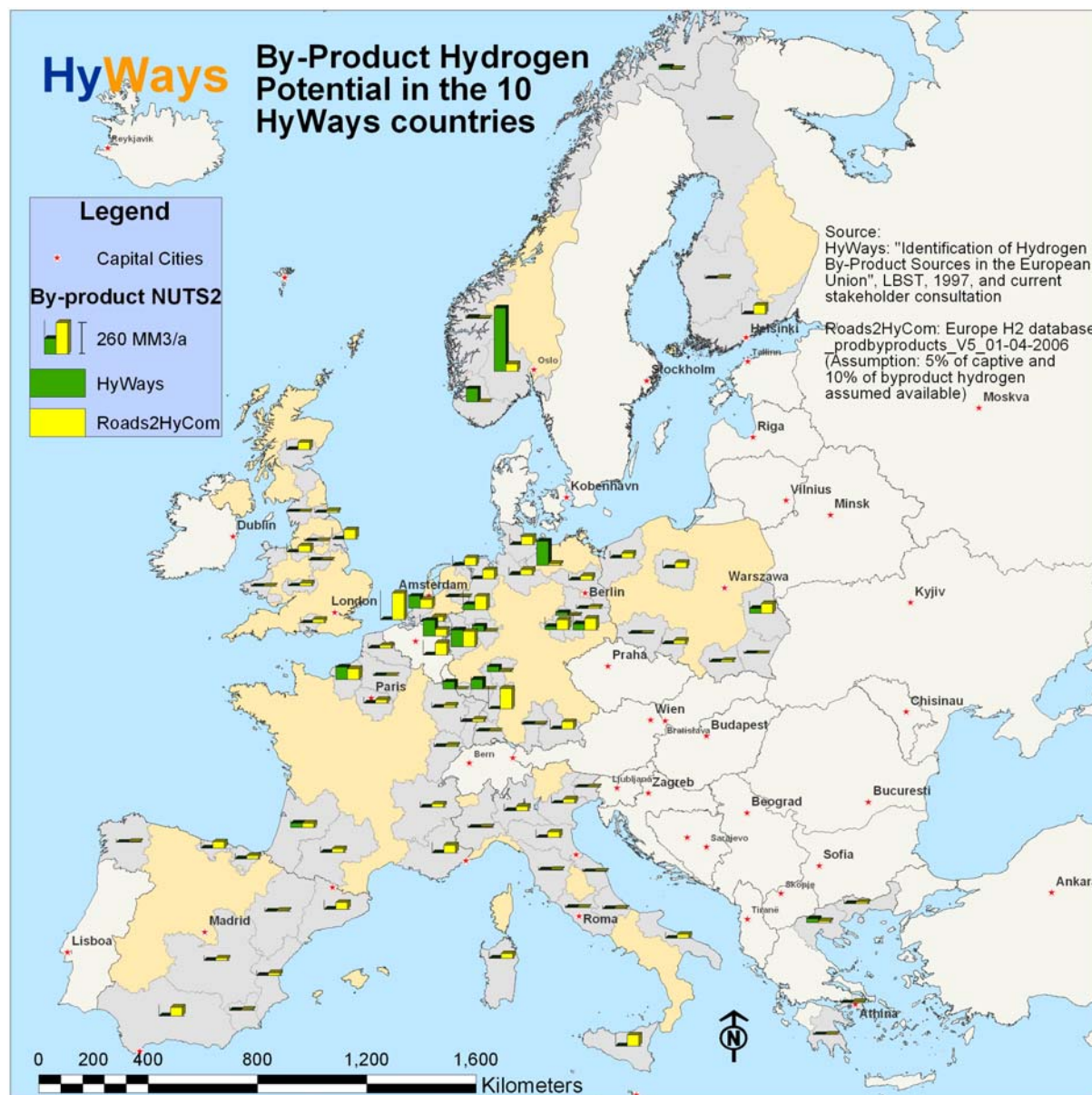


Figure 4: Comparison of the estimated data for by-product hydrogen from a previous study (see also 4.1.) and this study's calculation (source: HyWays).



## 5. Conclusions

From the given estimate with the different excess margin scenarios it appears that a **potential of between 2 and 10bn Nm<sup>3</sup> hydrogen** might be available as "surplus hydrogen" in Europe, either in the form of excess capacity or by-product hydrogen. These qualitative results are not too far from the data presented by LUDWIG-BÖLKOW-SYSTEMTECHNIK (1999) which calculated a potential of 5bn m<sup>3</sup>.

The presented surplus volume is far from negligible: with 2-10bn Nm<sup>3</sup> hydrogen it is possible to supply between 1 and 6 million vehicles. This number represents 1.5-3% of all vehicles in the EU (estimated at 190m) and would cover a substantial Hydrogen Community or early adopter market, probably in locations closest to the surplus (it is, for example, much more than the total number of fossil-fuelled hybrid vehicles in the market today).

Numbers should be used with care, though, as the analysis is based purely on statistical assumptions and has not investigated actual capacity factors of plants. Therefore, the given numbers represent the estimated amount of hydrogen which will be available in total at the average production rate of European captive sources today. This will not necessarily hold for a specific location and production facility at any given time, since this will have its own schedules of production. In order to have a more precise estimation it will be necessary to collect real data, not just estimations, on a site-by-site basis. However, from the experience in this project it seems far from easy or even possible to obtain these data from the owner of the plants due to various reasons including trade secrets.

Consideration should also be given to the quality of the surplus hydrogen. Impurities in hydrogen can be an issue for use in PEFC, for example. Therefore gas-cleanup technologies might have to be considered when planning for projects using surplus hydrogen in order to meet the specifications laid down by fuel cell suppliers.

As each method of production presents specific issues in terms of quality it is not possible to give an overall figure of how much of the identified surplus hydrogen would need to be treated downstream and how, but it can certainly be said that purification will add extra cost that needs to be considered in any further analysis. Still, besides these extra costs, available hydrogen does exist and this surplus hydrogen can well be considered as a potential hydrogen source for the transition phase.

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based on an annual distance of 14,000 km per vehicle and a unit consumption of 1kg H<sub>2</sub>/100 km or (11.1 m<sup>3</sup> H<sub>2</sub>/100 km); the annual consumption is then 1500 m<sup>3</sup> H<sub>2</sub>/year for one vehicle or 1.5bn m<sup>3</sup> H<sub>2</sub> for 1m cars

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## References

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## Annex 1: Hydrogen production by regions – sorted by regions

Zone	Country	NUTS 1	NUTS2	bn m <sup>3</sup> /year		
EU 25	Austria	Ostösterreich	Niederösterreich	0.00		
			Wien	0.32		
		<i>Total Ostösterreich</i>			<i>0.32</i>	
		Südösterreich	Kärnten	0.02		
		Westösterreich	Öberösterreich	1.53		
		<b>Total Austria</b>			<b>1.86</b>	
		Belgium	Région Wallonne	Prov. Hainaut	Prov. Hainaut	0.68
					Prov. Liège	0.37
					Prov. Namur	0.05
				<i>Total Région Wallonne</i>		
Vlaams Gewest	Antwerpen			3.92		
	Prov. Limburg			0.08		
	Prov. Oost-Vlaanderen			0.59		
<i>Total Vlaams Gewest</i>				<i>4.58</i>		
<b>Total Belgium</b>				<b>5.69</b>		
Czech Republic	Ceska Republika			Severozapad	Severozapad	0.17
		Smoravskoslezsko	0.67			
		Stredni Cechy	0.11			
		<b>Total Czech Republic</b>			<b>0.95</b>	
Denmark	Danmark	Danmark	0.17			
<b>Total Denmark</b>			<b>0.17</b>			
Finland	Manner-Suomi	Etelä-Suomi	Etelä-Suomi	1.34		
			Länsi-Suomi	0.11		
			Pohjois-Suomi	0.05		
		<i>Total Manner-Suomi</i>			<i>1.49</i>	
		n/a	n/a	0.27		
<b>Total Finland</b>			<b>1.77</b>			
France	Bassin Parisien	Bourgogne	Bourgogne	0.01		
			Haute-Normandie	1.93		
			Picardie	0.01		
		<i>Total Bassin Parisien</i>			<i>1.95</i>	
		Centre-Est	Rhône-Alpes	0.50		



Zone	Country	NUTS 1	NUTS2	bn m <sup>3</sup> /year
		Est	Alsace	0.55
			Franche-Comté	0.10
			Lorraine	0.17
		<i>Total Est</i>		<i>0.83</i>
		Île de France	Île de France	0.59
		Méditerranée	Provence-Alpes-Côte d'Azur	1.74
		Nord-Pas de Calais	Nord-Pas de Calais	0.42
		Sud-Ouest	Aquitaine	0.50
			Midi-Pyrénées	0.61
		<i>Total Sud-Ouest</i>		<i>1.11</i>
	<b>Total France</b>			<b>7.13</b>
	<b>Germany</b>	Baden-Württemberg	Freiburg	0.03
			Tübingen	0.00
		<i>Total Baden-Württemberg</i>		<i>0.03</i>
		Bayern	Oberbayern	1.41
			Schwaben	0.02
		<i>Total Bayern</i>		<i>1.42</i>
		Brandenburg	Brandenburg - Südwest	0.24
			Brandenburg-Nordost	0.65
		<i>Total Brandenburg</i>		<i>0.89</i>
		Bremen	Bremen	0.00
		Hamburg	Hamburg	0.31
		Hessen	Darmstadt	0.05
		Niedersachsen	Braunschweig	0.68
			Lüneburg	0.59
			Weser-Ems	1.44
		Nordrhein-Westfalen	Detmold	0.00
			Düsseldorf	2.52
			Köln	1.88
			Münster	2.73
		<i>Total Nordrhein-Westfalen</i>		<i>7.13</i>
		Rheinland-Pfalz	Koblenz	0.00
			Rheinhessen-Pfalz	2.52
			Trier	0.59
		<i>Total Rheinland-Pfalz</i>		<i>3.10</i>
		Sachsen	Dresden	0.01



Zone	Country	NUTS 1	NUTS2	bn m <sup>3</sup> /year
			Leipzig	1.83
		<i>Total Sachsen</i>		<i>1.84</i>
	Sachsen-Anhalt		Dessau	0.04
			Halle	2.59
			Magdeburg	0.06
		<i>Total Sachsen-Anhalt</i>		<i>2.69</i>
	Schleswig-Holstein		Schleswig-Holstein	1.40
	Thüringen		Thüringen	0.01
	<b>Total Germany</b>			<b>21.53</b>
<b>Greece</b>		Attiki	Attiki	0.18
		Kentriki Ellada	Pelloponnisos	0.05
		Voreia Ellada	Anatoliki Makedonia, Thraki	0.27
			Kentriki Makedonia	0.25
		Total Voreia Ellada		0.52
	<b>Total Greece</b>			<b>0.75</b>
<b>Hungary</b>		Alfold es Eszak	Eszak-Mayorszag	0.07
		Dunantul	Kozep-Dunantul	0.60
		Mayorszag	Kozep-Mayorszag	0.35
	<b>Total Hungary</b>			<b>1.02</b>
<b>Ireland</b>	Ireland		Southern and Eastern	0.91
	<b>Total Ireland</b>			<b>0.91</b>
<b>Italy</b>		Centro	Lazio	0.01
			Marche	0.22
			Toscana	0.32
		<i>Total Centro</i>		<i>0.55</i>
		Isole	Sardegna	0.59
			Sicilia	2.21
		<i>Total Isole</i>		<i>2.80</i>
		Nord-Est	Emilia-Romagna	0.96
			Friuli-Venezia Giulia	0.02
			Veneto	0.59
		<i>Total Nord-Est</i>		<i>1.57</i>
		Nord-Ouest	Liguria	0.25
			Lombardia	0.75
			Piemonte	0.07
		<i>Total Nord-Ouest</i>		<i>1.07</i>



Zone	Country	NUTS 1	NUTS2	bn m <sup>3</sup> /year
		Sud	Abruzzo	0.04
			Basilicata	0.01
			Campania	0.00
			Puglia	0.56
		<i>Total Sud</i>		<i>0.62</i>
	<b>Total Italy</b>			<b>6.60</b>
<b>Lithuania</b>	Lietuva	Lietuva		0.64
	<b>Total Lithuania</b>			<b>0.64</b>
<b>Netherlands</b>	Noord-Nederland	Groningen		1.25
	Oost-Nederland	Overijssel		0.02
	West-Nederland	Noord-Holland		0.96
		Zeeland		4.21
		Zuid-Holland		1.43
	Zuid-Nederland	Limburg		1.80
		Noord-Brabant		0.39
	<b>Total Netherlands</b>			<b>10.06</b>
<b>Poland</b>	Centralny	Mazowieckie		0.04
	Polnocno - Zachodni	Zachodniopomorskie		0.80
	Polnocny	Kujawsko-Pomorskie		0.86
		Pomorskie		0.00
	<i>Total Polnocny</i>			<i>0.86</i>
	Poludniowo-Zachodni	Dolnoslaskie		0.03
		Opolskie		0.59
	<i>Total Poludniowo-Zachodni</i>			<i>0.62</i>
	Poludniowy	Malopolskie		0.27
		Slaskie		0.00
	<i>Total Poludniowy</i>			<i>0.27</i>
	Wschodni	Lubelskie		1.59
		Podkarpackie		0.01
	<i>Total Wschodni</i>			<i>1.57</i>
	<b>Total Poland</b>			<b>4.18</b>
<b>Portugal</b>	Continente	Alentejo		0.63
		Centro		0.09
		Lisboa		0.52
	<b>Total Portugal</b>			<b>1.24</b>
<b>Slovakia</b>	Slovenska Republika	Bratislavsky kraj		0.91
		Zapadne Slovensko		0.02



Zone	Country	NUTS 1	NUTS2	bn m <sup>3</sup> /year
	<b>Total Slovakia</b>			<b>0.93</b>
	<b>Slovenia</b>	Slovenija	Slovenija	0.00
	<b>Total Slovenia</b>			<b>0.00</b>
	<b>Spain</b>	Centro	Castilla-La Mancha	0.71
		Este	Cataluña	0.66
			Comunidad Valenciana	0.45
		<i>Total Este</i>		<i>1.11</i>
		Noreste	Aragón	0.07
			Galicia	0.01
			País Vasco	0.51
		<i>Total Noreste</i>		<i>0.59</i>
		Noroeste	Cantabria	0.53
			Galicia	0.38
			Principado de Asturias	1.11
		<i>Total Noroeste</i>		<i>2.02</i>
		Sur	Andalucía	1.35
			Andalucía	0.03
			Región de Murcia	0.14
		<i>Total Sur</i>		<i>1.51</i>
	<b>Total Spain</b>			<b>5.94</b>
	<b>Sweden</b>	Sverige	Mellersta Norrland	0.13
			Norra Mellansverige	0.00
			Östra Mellansverige	0.00
			Övre Norrland	0.31
			Stockholm	0.26
			Sydsverige	0.04
			Västsverige	0.61
	<b>Total Sweden</b>			<b>1.35</b>
	<b>United Kingdom</b>	East Midlands	Derbyshire and Nottinghamshire	0.01
		East of England	Essex	0.00
		North East	Tees Valley and Durham	1.42
		North West	Cheshire	0.80
			Cumbria	0.01
			Merseyside	0.02
		<i>Total North West</i>		<i>0.83</i>
		Scotland	Eastern Scotland	0.84



Zone	Country	NUTS 1	NUTS2	bn m <sup>3</sup> /year
			Southwestern Scotland	0.01
		<i>Total Scotland</i>		<i>0.85</i>
	South East		Hampshire and Isle of Wight	0.53
	Wales		East Wales	0.00
			West Wales and the Valleys	0.70
		<i>Total Wales</i>		<i>0.71</i>
	West Midlands		Herefordshire, Worcestershire and Warwickshire	0.49
	Yorkshire and the Humber		East Riding and North Lincolnshire	2.72
			West Yorkshire	0.02
		Total Yorkshire and the Humber		2.75
	<b>Total United Kingdom</b>			<b>7.58</b>
<b>Total EU 25</b>				<b>80.3</b>
<b>Total</b>				<b>92.1</b>



Zone	Country	NUTS 1	NUTS2	bn m <sup>3</sup> /year	
CC	Bulgaria	Severna Bulgaria	Severoiztochen	0.32	
			Severozapaden	0.64	
		<i>Total Severna Bulgaria</i>			<i>0.96</i>
		Yuzhna Bulgaria	Yugoiztochen	0.10	
			Yuzhen tsentralen	0.72	
		<i>Total Yuzhna Bulgaria</i>			<i>0.83</i>
		<b>Total Bulgaria</b>			<b>1.79</b>
		Croatia	Hrvatska	Jadranska-Hrvatska	0.43
					Sredisjna-Hrvatska
				<b>Total Croatia</b>	
Romania	Romania	Centru	1.43		
			Nord-Est	1.02	
			Sud	0.08	
			Sud-Est	0.07	
			Sud-Vest	0.95	
			(vide)	1.91	
			<b>Total Romania</b>		
Turkey	n/a	n/a	2.20		
			<i>Total (vide)</i>	<i>2.20</i>	
<b>Total Turkey</b>			<b>2.20</b>		
<b>Total CC</b>				<b>10.24</b>	
EFTA	Iceland	Ísland	Ísland	0.04	
			<b>Total Iceland</b>		
	Norway	Norge	Nord-Norge	0.03	
			Sør-Østlandet	0.95	
			Vestlandet	0.01	
	<b>Total Norway</b>			<b>0.98</b>	
	Switzerland	Schweiz	Espace Mittelland	0.07	
				Nordwestschweiz	0.04
				Région Lémanique	0.45
				Zürich	0.00
<b>Total Switzerland</b>				<b>0.56</b>	
<b>Total EFTA</b>				<b>1.59</b>	

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## Annex 2: Hydrogen production by regions – sorted by production

Country	Region (NUTS level 1)	Region (NUTS level 2)	Production [bn m <sup>3</sup> /year]		
Netherlands	West-Nederland	Zeeland	4.21	<b>&gt;3</b>	
Belgium	Vlaams Gewest	Antwerpen	3.92		
Germany	Nordrhein-Westfalen	Münster	2.73	<b>2-3</b>	
United Kingdom	Yorkshire and the Humber	East Riding and North Lincolnshire	2.72		
Germany	Rheinland-Pfalz	Rheinhessen-Pfalz	2.52		
Germany	Sachsen-Anhalt	Halle	2.59		
Germany	Nordrhein-Westfalen	Düsseldorf	2.52		
Italy	Isole	Sicilia	2.21		
Turkey	(vide) Pays	(vide) Pays	2.20		
France	Bassin Parisien	Haute-Normandie	1.93	<b>1-2</b>	
Germany	Nordrhein-Westfalen	Köln	1.88		
Germany	Sachsen	Leipzig	1.83		
Netherlands	Zuid-Nederland	Limburg	1.80		
France	Méditerranée	Provence-Alpes-Côte d'Azur	1.74		
Poland	Wschodni	Lubelskie	1.59		
Austria	Westösterreich	Öberösterreich	1.53		
Germany	Niedersachsen	Weser-Ems	1.44		
Romania	Romania	Centru	1.43		
Netherlands	West-Nederland	Zuid-Holland	1.43		
Germany	Bayern	Oberbayern	1.41		
Germany	Schleswig-Holstein	Schleswig-Holstein	1.34		
Spain	Sur	Andalucia	1.37		
Finland	Manner-Suomi	Etelä-Suomi	1.34		
Netherlands	Noord-Nederland	Groningen	1.25		
Spain	Noroeste	Principado de Asturias	1.11		
United Kingdom	North East	Tees Valley and Durham	1.42		
Romania	Romania	Nord-Est	1.02		
Norway	Norge	Sør-Østlandet	0.95		<b>0.5-1bn</b>
Italy	Nord-Est	Emilia-Romagna	0.96		
Netherlands	West-Nederland	Noord-Holland	0.96		
Romania	Romania	Sud-Vest	0.95		
Slovakia	Slovenska Republika	Bratislavsky kraj	0.91		
Ireland	Ireland	Southern and Eastern	0.91		
Poland	Polnocny	Kujawsko-Pomorskie	0.86		
United Kingdom	Scotland	Eastern Scotland	0.84		
United Kingdom	North West	Cheshire	0.80		
Poland	Polnocno - Zachodni	Zachodniopomorskie	0.80		
Italy	Nord-Ouest	Lombardia	0.75		
Bulgaria	Yuzhna Bulgaria	Yuzhen tsentralen	0.72		
Spain	Centro	Castilla-La Mancha	0.71		



Country	Region (NUTS level 1)	Region (NUTS level 2)	Production [bn m <sup>3</sup> /year]
United Kingdom	Wales	West Wales and the Valleys	0.70
Belgium	Région Wallonne	Prov. Hainaut	0.68
Germany	Niedersachsen	Braunschweig	0.68
Czech Republic	Ceska Republika	Smoravskoslezsko	0.67
Spain	Este	Cataluña	0.66
Germany	Brandenburg	Brandenburg-Nordost	0.65
Bulgaria	Severna Bulgaria	Severozapaden	0.64
Lithuania	Lietuva	Lietuva	0.64
Portugal	Continente	Alentejo	0.63
France	Sud-Ouest	Midi-Pyrénées	0.61
Sweden	Sverige	Västsverige	0.61
Hungary	Dunantul	Kozep-Dunantul	0.60
France	Île de France	Île de France	0.59
Poland	Poludniowo-Zachodni	Opolskie	0.59
Italy	Nord-Est	Veneto	0.59
Germany	Niedersachsen	Lüneburg	0.59
Italy	Isole	Sardegna	0.59
Belgium	Vlaams Gewest	Prov. Oost-Vlaanderen	0.59
Germany	Rheinland-Pfalz	Trier	0.59
Italy	Sud	Puglia	0.56
France	Est	Alsace	0.55
Spain	Noroeste	Cantabria	0.53
United Kingdom	South East	Hampshire and Isle of Wight	0.53
Portugal	Continente	Lisboa	0.52
Spain	Noreste	País Vasco	0.51
France	Centre-Est	Rhône-Alpes	0.50
France	Sud-Ouest	Aquitaine	0.50
United Kingdom	West Midlands	Herefordshire, Worcestershire and Warwickshire	0.49
Spain	Este	Comunidad Valenciana	0.45
Switzerland	Schweiz	Région Lémanique	0.45
Croatia	Hrvatska	Jadranska-Hrvatska	0.43
France	Nord-Pas de Calais	Nord-Pas de Calais	0.42
Netherlands	Zuid-Nederland	Noord-Brabant	0.39
Spain	Noroeste	Galicia	0.38
Belgium	Région Wallonne	Prov. Liège	0.37
Croatia	Hrvatska	Sredisjna-Hrvatska	0.36
Hungary	Mayorszag	Kozep-Mayorszag	0.35
Austria	Ostösterreich	Wien	0.32
Bulgaria	Severna Bulgaria	Severoiztochen	0.32
Italy	Centro	Toscana	0.32
Sweden	Sverige	Övre Norrland	0.31
Germany	Hamburg	Hamburg	0.31
Finland	(vide)	(vide)	0.27



Country	Region (NUTS level 1)	Region (NUTS level 2)	Production [bn m <sup>3</sup> /year]
Greece	Voreia Ellada	Anatoliki Makedonia, Thraki	0.27
Poland	Poludniowy	Malopolskie	0.27
Greece	Voreia Ellada	Kentriki Makedonia	0.26
Sweden	Sverige	Stockholm	0.26
Italy	Nord-Ouest	Liguria	0.25
Germany	Brandenburg	Brandenburg - Südwest	0.24
Italy	Centro	Marche	0.22
Greece	Attiki	Attiki	0.18
France	Est	Lorraine	0.17
Denmark	Danmark	Danmark	0.17
Czech Republic	Ceska Republika	Severozapad	0.17
Spain	Sur	Región de Murcia	0.14
Sweden	Sverige	Mellersta Norrland	0.13
Czech Republic	Ceska Republika	Stredni Cechy	0.11
Finland	Manner-Suomi	Länsi-Suomi	0.11
Portugal	Continente	Centro	0.10
Bulgaria	Yuzhna Bulgaria	Yugoiztochen	0.10
France	Est	Franche-Comté	0.10

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## **Annex 3: Examples of by-product valorisation – press releases**

### **Western Europe - Netherlands (Project PemPowerPlant)**

*Akzo Nobel's Base Chemicals business has successfully launched the first phase of a pilot hydrogen power plant with project partner NedStack.*

#### [Press release](#)

The two companies recently launched a three-year research project to determine the feasibility of setting up a power plant based on fuel cells and the PEM fuel cell system being developed is now up and running at Akzo Nobel's pilot plant based in Arnhem, the Netherlands.

NedStack has installed proton exchange membrane fuel cells that consume the hydrogen produced at the pilot plant and convert this hydrogen to electric power. Measured electrical efficiency of the fuel cells in this "real life" situation is currently 61.8 percent.

Installation and operation of the chlorine electrolysis pilot plant is just the first step in the development of a proposed 50 MW fuel cell power plant which will result in a substantial reduction of net energy consumption.

From 2006, a pilot plant based on a fuel cell module of 50 kW will be installed at Akzo Nobel's chemicals site in Rotterdam. Preliminary specifications for this fuel cell power plant are: 50 MW nominal power, 200 MW rated fuel cell peak power, 60 percent electrical efficiency, zero emission and 40,000 hours fuel cell operating time without maintenance.

During the project—which is supported by the Dutch Ministry of Economic Affairs—NedStack and Akzo Nobel will develop and build a pilot power module to prove feasibility, test reliability and design the full-scale fuel cell power plant.



## Western Europe - Norway (Hynor)

Norway's Minister of Transport and Communication, Torild Skogsholm, announced that some NOK 50 million is earmarked for testing alternative fuels and environmentally friendly technology. About NOK 30 million of this will go to the Hydro-led HyNor project - which wants to build a hydrogen highway between the cities of Oslo and Stavanger.

### [Press release](#)

[http://www.hydro.com/en/press\\_room/news/archive/2005\\_05/hydrogenroad\\_en.html](http://www.hydro.com/en/press_room/news/archive/2005_05/hydrogenroad_en.html)

The Research Council of Norway, on behalf of the Ministry of Transport and Communication, has granted a total of NOK 48.6 million to a series of projects and the testing of hydrogen and biological fuels.

"Since 2001, we have tripled funds allotted by the Ministry of Transport and Communication's budget towards alternative fuels and environmentally friendly technology," said Skogsholm.

"Norway will be a trendsetter in using such technology, and it's a great pleasure to have received so many exciting and solid applications. This includes the comprehensive HyNor project, which I have great hopes for."

### Oslo-Stavanger on hydrogen

A total NOK 30.2 million is set aside to the HyNor project, a national development endeavor to utilize hydrogen in the Norwegian transport sector. The project's ambition is to build a hydrogen highway between Oslo and Stavanger, develop hydrogen-powered vehicles and establish hydrogen filling stations, between now and 2008.

"We're very pleased," stated HyNor project leader, Christopher Kloed, from Hydro. "We're now finally beginning to see the contours of the hydrogen highway from Stavanger to Oslo and have come a significant step closer to realizing Norway's first hydrogen filling station."

### Hydrogen filling station in Porsgrunn

Some NOK 16.2 million of the means earmarked for HyNor is Hydro's project to establish a hydrogen filling station in the industrial area of Grenland in Porsgrunn. The filling station may be located in close proximity to Hydro's research park there, and could utilize **surplus hydrogen manufactured by established industry in the area.**

The hydrogen station at Herøya in Porsgrunn will be connected to the petrochemical plants at Rafnes. The hydrogen from Rafnes will be transported by pipeline to Herøya.



HYDROGEN HIGHWAY: HyNor wants to make it possible to drive between Oslo and Stavanger in hydrogen-powered vehicles.



## Western Europe - Italy

[Press release](#) (Venice)

[https://www.hfpeurope.org/uploads/1095/1622/HydrogenParkVenezia\\_MATTIELLO\\_051209\\_FINAL.pdf](https://www.hfpeurope.org/uploads/1095/1622/HydrogenParkVenezia_MATTIELLO_051209_FINAL.pdf)

[Press release](#)

[http://www.iphe.net/IPHE Paris/H2\\_Enti\\_Italia\\_Modifica01.ppt](http://www.iphe.net/IPHE Paris/H2_Enti_Italia_Modifica01.ppt)

Integrated project for stationary and automotive applications with 6000-7000 m<sup>3</sup>/h available from chlorine processes of the nearby chemical plants which are currently used for heat production

Key facts:

Stationary:

- MCFC (500 kWe) integrated with cogeneration plant
- hydrogen pipeline in urban area
- Micro CHP (PEM) for small buildings
- coal gasification.

Automotive:

- hydrogen Vaporetto
- hydrogen – methane mixtures
- refuelling station.

### Main characteristics of the supplying plants

	<b>Syndial</b>	<b>Polimeri</b>	<b>Dow</b>	<b>Arkema</b>
<b>Source</b>	Chloro-alkaline plant	Oil cracking for ethylene	H <sub>2</sub> from Syndial for CH <sub>4</sub> reforming	HCN production
<b>m<sup>3</sup>/h</b>	4500	6000	(500)	6500
<b>T °C</b>	ambient	ambient	ambient	15
<b>P (bar)</b>	2.5	27-34	15	1.7
<b>H<sub>2</sub>% (vol) min/mean</b>	99.5 / 99.97	90 / 96	n/a / 99.95	16.9 / 31.4
<b>N<sub>2</sub></b>	0.02	1.0	0.015	56.2
<b>Co</b>		0.2	<0.01	8.1
<b>CH<sub>4</sub></b>		2.8	0.02	0.3
<b>ethylene</b>		0.006		<0.01
<b>Ar</b>				1.0
<b>H<sub>2</sub>O</b>				1.0
<b>CO</b>			0.015	1.0



## North America - United States

*Dow and GM Launch Phase II of World's Largest Industrial Fuel Cell Program*

[Press release](#)

[http://news.dow.com/dow\\_news/corporate/2004/20041129b.htm](http://news.dow.com/dow_news/corporate/2004/20041129b.htm)

The Dow Chemical Company and General Motors Corp., today launched the second phase of their joint project to prove the viability of hydrogen fuel cells for motor vehicles and possibly for distributed power generation. The project has now expanded from a single GM test cell, installed in February 2004, to a multi-cell pilot plant at Dow's Texas Operations in Freeport, TX.

"In the first phase of this project, we collectively learned a lot about generating power from byproduct hydrogen via fuel cell technology, and now we're ready to build on what we've learned," said Gordon Slack, Dow's Global Business Director for Energy and Climate Change. "Dow is excited to contribute to this important project. It represents another step in the search for cost-effective fuel alternatives, with the potential to help reduce greenhouse gas emissions."

### **From a Test Cell to a Pilot Plant**

During the second phase, the fuel cell pilot plant will be integrated into Dow's chemical and plastics production facility via the power distribution grid and Dow's hydrogen clean-up and pipeline system. While generating real-world data to enable further development of the technology, these fuel cells will also supply up to 1 megawatt of energy for use in Dow's Texas Operations.

Phase II objectives include: building on key learnings from Phase I and demonstrating fuel cell reliability for Distributed Generation; improving and optimizing the reliability of power from the fuel cells; investigating fuel cell waste heat recovery opportunities; and understanding hydrogen purity requirements.

"The biggest benefit for GM is learning to work with real world hydrogen that has some impurities in it, and not the pure hydrogen you get in a lab setting," explained Timothy Vail, GM's director of business development for fuel cell activities. "Not only can we test the effects of hydrogen purity, we can also test different generations of fuel cells, all in a controlled setting. We learn about durability and reliability. GM is excited about the progress of the Dow installation. Moving from the test stage to the pilot stage represents a big leap forward in system design."

### **A Step Toward Cost-Effective and Sustainable Energy**

If Phase II proves successful, the project will transition to Phase III, large-scale commercialization by 2007. Ultimately, Dow and GM could install up to 400 fuel cells at Dow facilities, to generate 35 megawatts of electricity, equivalent to the amount of power needed for 25,000 average sized American homes.

"This project is yet another demonstration of our commitment to exploring cost-effective alternatives to fossil fuels for power generation," said George Kehler, Dow's Commercial Manager for Renewable and Alternative Energy. "We strongly support efforts to increase fuel diversity in the U.S. and to reduce our nation's dependence on extremely high-priced domestic natural gas. Inflated and volatile domestic energy and feedstock costs continue to undermine the global competitiveness of U.S. manufacturers. For the sake of our nation's economy, we need to find better solutions. Fuel cell technology can be a part of that solution in the future."



## North America – Canada

### [Press release](#)

<http://news.gc.ca/cfmx/view/en/index.jsp?articleid=174809&keyword=IWHUP&keyword=IWHUP&>

VANCOUVER, British Columbia, October 13, 2005 -- The Honourable David L. Emerson, Minister of Industry, and Don Bell, Member of Parliament for North Vancouver, today announced a \$12.2-million federal contribution to support the development and demonstration of the Integrated Waste Hydrogen Utilization Project (IWHUP) in the Vancouver area.

This project will develop and demonstrate clean energy solutions that make use of an existing but currently untapped source of hydrogen fuel: **hydrogen emitted as the by-product of a sodium chlorate manufacturing plant** in the North Vancouver area. Through this project, purified hydrogen could be used to fuel a fleet of up to 20,000 vehicles in the Vancouver area, greatly reducing greenhouse gas emissions and the use of fossil fuels.

This three-year project, led by North Vancouver-based Sacré-Davey Innovations Inc., working with Westport Innovations Inc. and Sacré-Davey Engineering, received a contribution of \$6.0 million from the Hydrogen Early Adopters (h2EA) program, \$5.9 million from Sustainable Development Technology Canada (SDTC), and \$273 000 from Natural Resources Canada's Canadian Transportation Fuel Cell Alliance (CTFCA). This support has been leveraged by a contribution of \$6.1 million from industry for a total project value of \$18.3 million.

"Protecting our environment calls on industry, government and individual Canadians to participate and cooperate in a meaningful way, making changes that have an impact," said Minister Emerson.

"Projects like this demonstrate a public and private sector commitment to making the hydrogen economy a reality, and to promoting innovation and demonstration of the real potential of green energy technologies here in Canada," added Don Bell.

"The Government of Canada continues to work with Canadians to research and develop clean energy solutions and innovative approaches to energy production," said the Honourable John McCallum, Minister of National Revenue and Acting Minister of Natural Resources, on behalf of the Honourable Stéphane Dion, Minister of the Environment. "By supporting projects such as the Integrated Waste Hydrogen Utilization Project, we can help build a solid foundation for moving forward on climate change and ensuring our future prosperity. These measures also support Project Green, the Government of Canada's action plan to build a more sustainable environment."

In addition to the recipients of this contribution, other project participants include: Clean Energy, Dynetek Industries Ltd., Easywash Inc., Hydrogen Technology & Energy Corporation, Nuvera Fuel Cells, Powertech Labs, Questair Technologies Inc., and TransLink.

"Today's announcement further builds momentum in the creation of a sustainable development technology infrastructure in Canada," said Vicky J. Sharpe, SDTC's President and CEO. "We also see the strides that we can make when SDTC facilitates the assembly of industry partners along the supply chain -- product developers, distributors and customers -- to accelerate the market success of clean technologies. Our strategic



approach is to do more than fund projects. We help to build consortia to create a full-scale market test."

The project will also demonstrate the full hydrogen value chain that includes the supply, storage, distribution and use of hydrogen. The demonstration will involve the operation of eight light-duty trucks running on hydrogen, four public transit buses converted to run on a combination of compressed natural gas and hydrogen, and a fuel cell system operating on hydrogen and providing electrical power and heat to a car wash.

The North Vancouver fuel station of IWHUP is one of the key stops on the BC Hydrogen Highway<sup>TM</sup> that will play a role in sustainable transportation demonstrations for the Vancouver/Whistler 2010 Olympic and Paralympic Winter Games.

"This support is vital to our ability to demonstrate and improve upon the kind of technologies that will lead Canada towards a hydrogen economy," said Chris Sacré of Sacré-Davey Innovations Inc. "Exploring ways to utilize by-product hydrogen will translate into creating a viable source of green energy in the not-so-distant future."

The h2EA program encourages Canadian companies to participate in a consortium of at least two organizations and demonstrate hydrogen and hydrogen-compatible technologies in real-world applications to accelerate the adoption of such technologies. The program intends to promote the awareness and acceptance of the broad environmental, economic and social benefits of a hydrogen economy.

SDTC is a foundation created by the Government of Canada that operates a \$550-million fund to support the development and demonstration of clean technologies -- solutions that address issues of climate change, clean air, and water and soil quality to deliver environmental, economic and health benefits to Canadians.

The CTFCA is a \$33-million federal government initiative that will demonstrate and evaluate fuelling options for fuel cell vehicles in Canada. Different combinations of fuels and fuelling systems will be demonstrated by 2008 for light, medium and heavy-duty vehicles.



## North America – Canada

*Dynetek Participates in Government of Canada Funded Waste Hydrogen Utilization Project. (same project as above)*

[Press release](#)

<http://www.dynetek.com/uploads/IWHUP.pdf>

Dynetek Industries Ltd. (“Dynetek”), a leader in developing, producing and marketing lightweight compressed natural gas (CNG) and compressed hydrogen storage cylinders, announced today its participation in the Integrated Waste Hydrogen Utilization Project (IWHUP), a Government of Canada and Sustainable Development Technology Canada (SDTC) funded project in Vancouver, BC. This hydrogen Early Adopters (h2EA) program and the SDTC contributions are part of an \$18.3 million hydrogen, and hydrogen compatible technologies demonstration project.

“Protecting our environment calls on industry, government and individual Canadians to participate and cooperate in a meaningful way, making changes that have an impact,” said the Honourable David L. Emerson, Minister of Industry. “Projects like this demonstrate a public and private sector commitment to making the hydrogen economy a reality, and to promoting innovation and demonstration of the real potential of green energy technologies here in Canada,” added Don Bell, MP, North Vancouver.

This three-year project was also awarded funding by Sustainable Development Technologies Canada, a not-for-profit foundation that finances and supports the development and demonstration of clean technologies across Canada. In addition, the project received an investment from Natural Resources Canada’s Canadian Transportation Fuel Cell Alliance (CTFCA).

This demonstration project involves Dynetek in participation with eleven other industry partners including: Sacre-Davey Innovations; Westport Innovations Inc.; Powertech Labs; Nuvera Fuel Cells; Clean Energy Fuels; Translink; Easywash; HTEC; Questair. Working together, the project members will develop hydrogen energy solutions that will make use of purified waste hydrogen from a sodium chlorate manufacturing plant. This project will cover the full hydrogen value chain, including: capture, storage, delivery, and mobile and stationary applications.

The demonstration project will operate eight light-duty trucks that will run on hydrogen using Dynetek’s Dynecell® cylinders and Advanced Lightweight Fuel Storage Systems™. Dynetek will provide a 450bar (6,500 psi), inter-modal compressed hydrogen storage and transportation system, similar to the many Hydrogen tube trailers currently in service throughout North America. This high volume Hydrogen transport system will be capable of supplying Hydrogen fuel to many of the larger Hydrogen powered vehicles such as the four Hydrogen buses, which will be part of this project.

“Government participation in this early commercial project is vital to demonstrating to the public that Hydrogen is an alternate fuel for Canada’s future” said Robb Thompson, Dynetek’s President and CEO. “This project allows Dynetek to demonstrate that our Hydrogen storage technologies are ready to provide refueling infrastructure and onboard vehicle storage solutions that can contribute to a cleaner environment today.”

The Technology Partnerships Canada h2EA program is intended to accelerate the market adoption of hydrogen and hydrogen compatible technologies in Canada through funding



of demonstration projects, which showcase working technology models in real-world settings. The goal of this demonstration project is to promote awareness and acceptance of the immense potential of a hydrogen economy, combined with other alternative fuels for industry and for Canadians.



## Asia – Japan

### [Press release](#)

[http://www.jhfc.jp/data/seminar\\_report/04/pdf/01\\_h17seminar\\_e.pdf](http://www.jhfc.jp/data/seminar_report/04/pdf/01_h17seminar_e.pdf)

### About JHFC

Hydrogen & Fuel Cell Demonstration Project consists of the fuel cell demonstration program (included in the support project for "empirical and other research on solid high-polymer fuel cell systems" under the auspices of the Ministry of Economy, Trade and Industry) and the Demonstration Study of Hydrogen Fueling Facilities for Fuel Cell Vehicles.

Part of hydrogen will be recover from a steel factory. Nippon Steel has experience in recovering hydrogen from **by-product gas**, and is actively working on national projects such as the Japan Hydrogen & Fuel Cell (JHFC) Demonstration Project and the Development of High-Efficiency Hydrogen Production Technology using Sensible Heat in Steelmaking Processes.

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## Annex 4: Industrial hydrogen production sites

ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
1	EU 25	AT123	Austria - Österreich	Sankt Pölten	Herzogenburg	Messer Austria GmbH				Merchant
2	EU 25	AT127	Austria - Österreich	Wiener Umland-Südteil	Gumpoldskirchen	Messer Austria GmbH				Merchant
3	EU 25	AT130	Austria - Österreich	Wien	Schwechat	OMV	720	SR + PSA	Refinery	Captive
4	EU 25	AT130	Austria - Österreich	Wien	Schwechat	OMV	180	Ethylene		
5	EU 25	AT211	Austria - Österreich	Klagenfurt-Villach	Weissenstein ob der Drau	Degussa		SR + PSA	H <sub>2</sub> O <sub>2</sub> production. Excess H <sub>2</sub> marketed by outside gas company.	Captive
6	EU 25	AT213	Austria - Österreich	Unterkärnten	Brückl	Donau Chemie	44	CS	Hydrochloric acid	By-Product
7	EU 25	AT312	Austria - Österreich	Linz-Wels	Linz	Linde	12		Part of the hydrogen is supplied to Agrolinz Melamin GmbH	Merchant
8	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	BASF	416	Ethylene		By-Product
9	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Fina Antwerp Olefins	744	Ethylene		By-Product
10	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	BASF	74	CS		By-Product
11	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	BASF	301	Styrene		By-Product

Abbreviations of processes as following:

CK: Chlorine potassium hydroxide electrolysis  
POX: Partial Oxidation  
SMR: Steam Methane Reformer  
WE: Water Electrolysis

COG: Coke oven gas  
PSA: Pressure Swing Adsorption  
SR: Steam Reformer

CS: Chlorine sodium hydroxide electrolysis  
S: Sodium chlorate  
TCR: Topsøe Convection Reformer



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
12	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Air Liquide	204	SMR + PSA	on BASF site; supplies refinery and petrochemistry and feeds pipeline	Merchant
13	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Air Liquide	2160	SMR + PSA	on BASF site; supplies refinery and petrochemistry and feeds pipeline	Merchant
14	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Air Liquide	2160	SMR + PSA	will double hydrogen production capacity on BASF site	Merchant
15	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Bayer-Shell Isocyanates	271	SR + PSA and CS by- product	Aniline.	Captive
16	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	ExxonMobil Chemical	1130	SMR	Refinery	Captive
17	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Total	337	SMR + PSA	Refinery	Captive
18	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	Bayer-Shell Isocyanates	32	CS	Hydrochloric acid	By-Product
19	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	SolVin SA (Solvay BASF)	156	CS	Hydrochloric acid	By-Product
20	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	SolVin SA (Solvay BASF)	82	CS	Aniline, sales	By-Product
21	EU 25	BE221	Belgium - Belgique - België	Arr. Hasselt	Tessenderlo	Tessenderlo Chemie	40	CS/CK	Hydrochloric acid, sales	By-Product
22	EU 25	BE221	Belgium - Belgique - België	Arr. Hasselt	Tessenderlo	Tessenderlo Chemie	187	CS		By-Product
23	EU 25	BE322	Belgium - Belgique - België	Charleroi	Feluy	Air Liquide	120	TCR		Merchant
24	EU 25	BE322	Belgium - Belgique - België	Charleroi	Feluy	Air Liquide	120	TCR		Merchant
25	EU 25	BE352	Belgium - Belgique - België	Arr. Namur	Jemeppe sur Sambre	SolVin SA (Solvay BASF)	148	CS	Hydrogen peroxide	By-Product



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
26	EU 25	CZ020	Czech Republic - Ceska Republika	Stredocesky kraj	Kralupy nad Vltavou	Ceska Rafinerska	240		Refinery	Captive
27	EU 25	CZ020	Czech Republic - Ceska Republika	Stredocesky kraj	Neratovice	SPOLANA a.s.	64	CS	chlorine-alkaline manufacturer	By-Product
28	EU 25	CZ042	Czech Republic - Ceska Republika	Ustecky kraj	Litvínov	Air Products		PSA	Recovery from chemical plant	Merchant
29	EU 25	CZ042	Czech Republic - Ceska Republika	Ustecky kraj	Litvínov	Ceska Rafinerska	650	SR	Refinery	Captive
30	EU 25	CZ042	Czech Republic - Ceska Republika	Ustecky kraj	Litvínov	Chemopetrol	76		Refinery	Captive
31	EU 25	CZ042	Czech Republic - Ceska Republika	Ustecky kraj	Usti nad Labem	SETUZA a.s.	12	SR	hydrogenation	Captive
32	EU 25	CZ042	Czech Republic - Ceska Republika	Ustecky kraj	Usti nad Labem	Spolek pro Chemickou a Hutni Vyrobu, a.s.	40	CS	chlorine-alkaline manufacture. hydrochloric acid	By-Product
33	EU 25	CZ080	Czech Republic - Ceska Republika	Moravskoslezsky kraj	Ostrava	BorsodChem	144	SR	convection reformer for aniline production	Captive
34	EU 25	CZ080	Czech Republic - Ceska Republika	Moravskoslezsky kraj	Ostrava	Moravske Chemicke Zavody a.s.	320	SR	aniline production	Captive
35	EU 25	DK002	Denmark - Danmark	Københavns amt	Klampenborg	Strandmollen Industrigas A/S			Klampenborg hydrogen production had been shut down earlier	Merchant
36	EU 25	DK003	Denmark - Danmark	Frederiksborg amt	Frederikssund	Haldor Topsøe AS	5	SR Methanol		Captive
37	EU 25	DK005	Denmark - Danmark	Vestsjællands amt	Kalundborg	Statoil	473	SMR		Captive
38	EU 25	DK008	Denmark - Danmark	Fyns Amt	Fyn	Strandmollen Industrigas A/S			Installation in Fyn shut down in 2003	Merchant
39	EU 25	DE126	Germany - Deutschland	Ludwigshafen am Rhein, Kreisfreie Stadt	Ludwigshafen	BASF	266	CS		By-Product



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
40	EU 25	DEF05	Germany - Deutschland	Dithmarschen	Brunsbüttel	Bayer AG	155	CS		By-Product
41	EU 25	DE126	Germany - Deutschland	Ludwigshafen am Rhein, Kreisfreie Stadt	Ludwigshafen	BASF	323	Ethylene		By-Product
42	EU 25	DED34	Germany - Deutschland	Leipziger Land	Boehlen	BSL Ethylene	265	Ethylene		By-Product
43	EU 25	DEF05	Germany - Deutschland	Dithmarschen	Heide	Shell & DEA Oil GmbH	57	Ethylene		By-Product
44	EU 25	DE126	Germany - Deutschland	Ludwigshafen am Rhein, Kreisfreie Stadt	Ludwigshafen	BASF	922	Acetylene		By-Product
45	EU 25	DE126	Germany - Deutschland	Ludwigshafen am Rhein, Kreisfreie Stadt	Ludwigshafen	BASF	262	Styrene		By-Product
46	EU 25	DEA1D	Germany - Deutschland	Neuss	Dormagen	Bayer AG	333	CS	Captive use for isocyanates and others	By-Product
47	EU 25	DEA1D	Germany - Deutschland	Neuss	Dormagen	Bayer AG	70	CS	Hydrochloric acid	By-Product
48	EU 25	DEA1D	Germany - Deutschland	Neuss	Niederkassel	Degussa	104	CS		By-Product
49	EU 25	DEA1F	Germany - Deutschland	Wesel	Rheinberg	Solvay	170	CS	Hydrochloric acid	By-Product
50	EU 25	DEA14	Germany - Deutschland	Krefeld, Kreisfreie Stadt	Uerdingen	Bayer AG	200	CS	Connected to Air Liquide pipeline; aniline	By-Product
51	EU 25	DEA17	Germany - Deutschland	Oberhausen, Kreisfreie Stadt	Oberhausen	European Oxo		SMR	Captive for chemicals	Captive
52	EU 25	DEA22	Germany - Deutschland	Bonn, Kreisfreie Stadt	Köln	BP	599	Ethylene		By-Product
53	EU 25	DEA23	Germany - Deutschland	Köln, Kreisfreie Stadt	Lülsdorf	Air Products	13			Merchant



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
54	EU 25	DEA23	Germany - Deutschland	Köln, Kreisfreie Stadt	Lülsdorf	Degussa	80	CS/CK	Link to pipeline; sales to Air Products	By-Product
55	EU 25	DEA24	Germany - Deutschland	Leverkusen, Kreisfreie Stadt	Leverkusen	Bayer AG	290	CS	Connected to Air Liquide pipeline	By-Product
56	EU 25	DEA27	Germany - Deutschland	Erfkreis	Hürth-Knapsack	Air Liquide	192	CS		By-Product
57	EU 25	DEA27	Germany - Deutschland	Erfkreis	Wesseling	Basell Polyolefine	531	Ethylene		By-Product
58	EU 25	DEA27	Germany - Deutschland	Erfkreis	Wesseling	Shell & DEA Oil GmbH	271	Ethylene		By-Product
59	EU 25	DEA27	Germany - Deutschland	Erfkreis	Wesseling	Shell & DEA Oil GmbH	1512	SMR + PSA	Refinery	Captive
60	EU 25	DEA31	Germany - Deutschland	Bottrop, Kreisfreie Stadt	Bottrop	Linde		SMR	On-site supply of hydrogen and carbon monoxide for Bayer AG and to RWE/Dea (Condea and Dea refinery, Heide)	Merchant
61	EU 25	DEA32	Germany - Deutschland	Gelsenkirchen, Kreisfreie Stadt	Gelsenkirchen	Ruhr Oel	657	SMR	Refinery	Captive
62	EU 25	DEA32	Germany - Deutschland	Gelsenkirchen, Kreisfreie Stadt	Gelsenkirchen	Ruhr Oel	1104	POX / Ethylene ?	Refinery	Captive
63	EU 25	DEA36	Germany - Deutschland	Recklinghausen	Marl	ISP Marl	326	Acetylene		By-Product
64	EU 25	DEA36	Germany - Deutschland	Recklinghausen	Marl	BP	211	Styrene		By-Product
65	EU 25	DEA36	Germany - Deutschland	Recklinghausen	Marl	Vestolit GmbH & Co KG	170	CS	Formerly Degussa-Huels	By-Product
66	EU 25	DEA37	Germany - Deutschland	Steinfurt	Ibbenbüren-Uffeln	Akzo Nobel	70	CS	Used to produce hydrochloric acid; 18% sold through pipeline to BASF, 13% used for steam generation, 16% sold in trailers to Air Liquide; 8 to 13% is flared	By-Product



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
67	EU 25	DEA37	Germany - Deutschland	Steinfurt	Salzbergen	Westfalen Chemie	60	SMR	Part of the production is marketed by Westfalen AG. Captive use by "SRS Schmierstoff-raffinerie Salzbergen GmbH"	Captive + Merchant
68	EU 25	DEA46	Germany - Deutschland	Minden-Lübbecke	Minden	Air Liquide	7	SMR	On-site plant for BASF	Merchant
69	EU 25	DEB17	Germany - Deutschland	Mayen Koblenz	Andernach	Air Liquide	6	SMR	On-site supply of hydrogen	Merchant
70	EU 25	DEB3D	Germany - Deutschland	Alzey-Worms	Offstein	Air Liquide	22	SMR	On-site plant for Südzucker	Merchant
71	EU 25	DED25	Germany - Deutschland	Meissen	Nünchritz	Air Liquide	34	SMR	On-site plant for Wacker Chemie	Merchant
72	EU 25	DEE14	Germany - Deutschland	Bitterfeld	Bitterfield	Linde		CS		Merchant
73	EU 25	DEE14	Germany - Deutschland	Bitterfeld	Bitterfield	Akzo Nobel	104	CS/CK	Whole production sold to Linde	By-Product
74	EU 25	DEE24	Germany - Deutschland	Merseburg-Querfurt	Leuna	Total	1360	SMR	Refinery	Captive
75	EU 25	DEE24	Germany - Deutschland	Merseburg-Querfurt	Leuna	Total	2500	SMR	Refinery	Captive
76	EU 25	DEE24	Germany - Deutschland	Merseburg-Querfurt	Schkopau	BSL Olefinverbund	163	CS	Mostly captively used by Dow	By-Product
77	EU 25	DEE24	Germany - Deutschland	Merseburg-Querfurt	Schkopau	BSL Olefinverbund	169	Styrene		By-Product
78	EU 25	DEE24	Germany - Deutschland	Merseburg-Querfurt	Leuna	Linde	1000	SMR	On-site supply for Total refinery, DOMO, Dow chemical, Radici Chimica and other customers; additional pipeline system of 500km length installed between Bitterfield, Buna and Leuna to supply various chemical plants	Merchant



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
79	EU 25	DEE24	Germany - Deutschland	Merseburg-Querfurt	Leuna	Linde	1000	SMR	CO shift of syngas from refinery	Merchant
80	EU 25	DEE24	Germany - Deutschland	Merseburg-Querfurt	Leuna	Linde	1000	SMR	added to pipeline system	Merchant
81	EU 25	DEE39	Germany - Deutschland	Schönebeck	Bernburg	Air Liquide	170	SMR	On-site plant for Solvay Interox's hydrogen peroxide plant	Merchant
82	EU 25	DEF05	Germany - Deutschland	Dithmarschen	Brunsbüttel	Linde	480	SMR	On-site plant for Wacker Chemie	Merchant
83	EU 25	DEG03	Germany - Deutschland	Jena, Kreisfreie Stadt	Jena	Air Liquide	18	SMR	On-site plant for Schott	Merchant
84	EU 25	DE126	Germany - Deutschland	Ludwigshafen am Rhein, Kreisfreie Stadt	Ludwigshafen	BASF	1300	POX	Captive for chemicals	Captive
85	EU 25	DE139	Germany - Deutschland	Lörrach	Rheinfelden	Degussa	74	CS + PSA	H <sub>2</sub> O <sub>2</sub> production	Captive
86	EU 25	DE148	Germany - Deutschland	Ravensburg	Aitrach-Marstetten	Sauerstoffwerk Friedrichshafen GmbH		mostly WE	Small	Merchant
87	EU 25	DE211	Germany - Deutschland	Ingolstadt, Kreisfreie Stadt	Ingolstadt	Linde	900	SMR + LH2	Surplus hydrogen from the Esso refinery; liquefaction capacity 4.4 t/day	Merchant
88	EU 25	DE211	Germany - Deutschland	Ingolstadt, Kreisfreie Stadt	Ingolstadt	BAYERNOIL Raffineriegesellschaft mbH	2350	SMR	Captive for chemicals	Captive
89	EU 25	DE21J	Germany - Deutschland	Pfaffenhofen a. d. Ilm	Münchsmünster	Veba OEL	156	Ethylene		By-Product
90	EU 25	DE214	Germany - Deutschland	Altötting	Burghausen	Linde	178			Merchant
91	EU 25	DE214	Germany - Deutschland	Altötting	Burghausen	OMV	161	Ethylene		By-Product



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
92	EU 25	DE214	Germany - Deutschland	Altötting	Burghausen	Wacker-Chemie GmbH, majority owned by the Wacker family	42	CS	Hydrochloric acid	By-Product
93	EU 25	DE214	Germany - Deutschland	Altötting	Burghausen	Vinnolit GmbH & Co KG	60	CS		By-Product
94	EU 25	DE214	Germany - Deutschland	Altötting	Gendorf	Dow	57	CS		By-Product
95	EU 25	DE276	Germany - Deutschland	Augsburg, Landkreis	Gersthofen	Clariant GmbH	44	CS	Sales to Air Liquide	By-Product
96	EU 25	DE418	Germany - Deutschland	Uckermark	Schwedt	PCK Raffinerie GmbH	213	SMR	Refinery	Captive
97	EU 25	DE418	Germany - Deutschland	Uckermark	Schwedt	PCK Raffinerie GmbH	840	SMR	Refinery	Captive
98	EU 25	DE427	Germany - Deutschland	Oberspreewald- Lausitz	Schwarzheide	BASF	200	SMR + PSA	Refinery	Captive
99	EU 25	DE501	Germany - Deutschland	Bremen, Kreisfreie Stadt	Bremen	Air Liquide	12	SMR	On-site plant for Stahlwerk Bremen	Merchant
100	EU 25	DE600	Germany - Deutschland	Hamburg	Hamburg	BP	8	SMR + PSA	Lubes refinery	Captive
101	EU 25	DE600	Germany - Deutschland	Hamburg	Hamburg	Holborn Europa Raffinerie GmbH	840	SMR	Refinery	Captive
102	EU 25	DE600	Germany - Deutschland	Hamburg	Hamburg	Sasol Olefins & Surfactants GmbH	14	SMR	Refinery	Captive
103	EU 25	DE712	Germany - Deutschland	Frankfurt am Main, Kreisfreie Stadt	Frankfurt am Main	LII Europe GmbH	144	CS	Marketed and distributed by Infraserv mostly to customers of the industry park	By-Product
104	EU 25	DE939	Germany - Deutschland	Stade	Stade	Air Liquide	192	POX	POX reactor n°1 in service until 2001; now interrupted but maintained under nitrogen inerting	Merchant



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
105	EU 25	DE939	Germany - Deutschland	Stade	Stade	Air Liquide	350	POX	POX reactor n°2 in operation. On-site supply of hydrogen and carbon monoxide for Dow Deutschland Inc.	Merchant
106	EU 25	DE939	Germany - Deutschland	Stade	Stade	Dow	1100	CS	Captive use and sales to outside companies	By-Product
107	EU 25	DE945	Germany - Deutschland	Wilhelmshaven, Kreisfreie Stadt	Wilhelmshaven	INEOS	110	CS		By-Product
108	EU 25	DE949	Germany - Deutschland	Emsland	Lingen	BP	3900	SR Naphta	Refinery	Captive
109	EU 25	ES111	Spain - España	A Coruña	La Coruña	Air Liquide	760	SMR	On-site for Repsol	Merchant
110	EU 25	ES111	Spain - España	A Coruña	La Coruña	Repsol	290		Refinery	Captive
111	EU 25	ES114	Spain - España	Pontevedra	Marisma de Lourizan	Electroquímica del Noroeste	25	CS	Hydrochloric acid	By-Product
112	EU 25	ES120	Spain - España	Asturias	Aviles	Praxair	240		Supplied to Dupont for tetrahydrofuran	Merchant
113	EU 25	ES130	Spain - España	Cantabria	Torrelavega	Solvay	1440	CS	Hydrochloric acid and hydrogen peroxide; some sales to Air Products and other companies.	By-Product
114	EU 25	ES130	Spain - España	Cantabria	Gajano	Air Liquide	30	SMR	On site supply for Dynasol Elastomeros (Grupo Repsol)	Merchant
115	EU 25	ES212	Spain - España	Guipuzcoa	Hernani	Aragonesas Industrias y Energia SA		PSA recovery from electro- chemical plant		Merchant
116	EU 25	ES212	Spain - España	Guipuzcoa	Hernani	Electroquímica de Hernani	7	S		By-Product
117	EU 25	ES212	Spain - España	Guipuzcoa	Hernani	Electroquímica de Hernani	10	CS	Hydrochloric acid and some sales	By-Product
118	EU 25	ES213	Spain - España	Vizcaya	Bilbao	Petronar	315		Refinery	Captive



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
119	EU 25	ES213	Spain - España	Vizcaya	Somorrostro Vizcaya	Solvay	1095	SMR	Refinery	Captive
120	EU 25	ES241	Spain - España	Huesca	Monzon del Rio Cinca	Quimica del Cinca	21	CS	Hydrochloric acid	By-Product
121	EU 25	ES241	Spain - España	Huesca	Sabiñánigo	Aragonesas Industrias y Energia SA	18	CS/CK	Fuel	By-Product
122	EU 25	ES241	Spain - España	Huesca	Sabiñánigo	Aragonesas Industrias y Energia SA	71	S		By-Product
123	EU 25	ES243	Spain - España	Zaragoza	La Zaida	FMC Foret, S.A.	48	PSA	Hydrogen peroxide	Captive
124	EU 25	ES243	Spain - España	Zaragoza	La Zaida	FMC Foret, S.A.	36			Captive
125	EU 25	ES422	Spain - España	Ciudad Real	Puertollano	Repsol	525		Refinery	Captive
126	EU 25	ES422	Spain - España	Ciudad Real	Puertollano	Air Liquide	1 170	SMR	On-site for Repsol	Merchant
127	EU 25	ES422	Spain - España	Ciudad Real	Puertollano	Repsol	169	Ethylene		By-Product
128	EU 25	ES422	Spain - España	Ciudad Real	Puertollano	Repsol	96	Styrene		By-Product
129	EU 25	ES511	Spain - España	Barcelona	Berga	Air Products				Merchant
130	EU 25	ES511	Spain - España	Barcelona	Martorell	SolVin SA (Solvay BASF)	142	CS	Hydrochloric acid and some sales to Air Products and other companies	By-Product
131	EU 25	ES511	Spain - España	Barcelona	Martorell	Hispanic Ibérica	161	CS		By-Product
132	EU 25	ES512	Spain - España	Girona	Blanes	Rhodia	54	PSA		Captive
133	EU 25	ES514	Spain - España	Tarragona	Flix	ERKIMIA SA	115	CS	Hydrochloric acid	By-Product
134	EU 25	ES514	Spain - España	Tarragona	Tarragona	Air Products	65		SMR	Merchant
135	EU 25	ES514	Spain - España	Tarragona	Tarragona	BASF	72	SMR	Captive for chemicals	Captive
136	EU 25	ES514	Spain - España	Tarragona	Tarragona	Repsol	263	SR Naphta	Refinery	Captive
137	EU 25	ES514	Spain - España	Tarragona	Tarragona	Dow	297	Ethylene		By-Product
138	EU 25	ES514	Spain - España	Tarragona	Tarragona	Repsol	205	Styrene		By-Product



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
139	EU 25	ES514	Spain - España	Tarragona	Tarragona	Repsol	312	Ethylene		By-Product
140	EU 25	ES514	Spain - España	Tarragona	Vilaseca	Aragonesas Industrias y Energia SA	148	CS	Hydrochloric acid and some sales	By-Product
141	EU 25	ES522	Spain - España	Castellón	Castellon de la Plana	BP	600	SMR	Refinery	Captive
142	EU 25	ES522	Spain - España	Castellón	Castellon de la Plana	Compania Espanola de Petroleos	657			Captive
143	EU 25	ES612	Spain - España	Cádiz	Cadiz	Compania Espanola de Petroleos	135		Refinery	Captive
144	EU 25	ES615	Spain - España	Huelva	Huelva	Compania Espanola de Petroleos	940		Refinery	Captive
145	EU 25	ES615	Spain - España	Huelva	La Rabida	Compania Espanola de Petroleos	708	SMR	Refinery	Captive
146	EU 25	ES615	Spain - España	Huelva	La Rabida	Compania Espanola de Petroleos	170		Refinery	Captive
147	EU 25	ES615	Spain - España	Huelva	Palos de la Frontera	Aragonesas Industrias y Energia SA	75	CS	Hydrochloric acid	By-Product
148	EU 25	ES618	Spain - España	Sevilla	Sevilla	Air Products				Merchant
149	EU 25	ES620	Spain - España	Murcia	Cartagena Murcia	Repsol	390		Refinery	Captive
150	EU 25	FI1A3	Finland - Suomi	Lappi	Oulu	Kemira Chemicals Oy			H <sub>2</sub> O <sub>2</sub> production	Captive
151	EU 25	FI1A3	Finland - Suomi	Lappi	Oulu	Eka Chemicals	30	CS	Hydrochloric acid and fuel	By-Product
152	EU 25	FI1A3	Finland - Suomi	Lappi	Oulu	Eka Chemicals	90	S	Hydrochloric acid and fuel	By-Product
153	EU 25	FI181	Finland - Suomi	Uusimaa	Espoo	Oy Woikoski AB				Merchant
154	EU 25	FI181	Finland - Suomi	Uusimaa	Helsinki	Linde	12			Merchant
155	EU 25	FI182	Finland - Suomi	Itä-Uusimaa	Porvoo	Borealis Polymers Oy	161	Ethylene		By-Product



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
156	EU 25	FI182	Finland - Suomi	Itä-Uusimaa	Porvoo	Fortum Oil and Gas Oy	3300	SMR	Refinery	Captive
157	EU 25	FI183	Finland - Suomi	Varsinais-Suomi	Raisio	Linde	17			Merchant
158	EU 25	FI186	Finland - Suomi	Kymenlaakso	Voikoski	Oy Woikoski AB		WE	from hydropower	Merchant
159	EU 25	FI186	Finland - Suomi	Kymenlaakso	Voikkaa	Oy Finnish Peroxides			H <sub>2</sub> O <sub>2</sub> production	Captive
160	EU 25	FI187	Finland - Suomi	Etelä-Karjala	Joutseno	Kemira Oy	55	CS		By-Product
161	EU 25	FI187	Finland - Suomi	Etelä-Karjala	Joutseno	Finnish Chemicals Oy	115	S		By-Product
162	EU 25	FI187	Finland - Suomi	Etelä-Karjala	Joutseno	Finnish Chemicals Oy	63	CS	hydrochloric acid	By-Product
163	EU 25	FI191	Finland - Suomi	Satakunta	Harjavalta	OMG Harjavalta Nickel Oy	60	SR Naphta	Metals	Captive
164	EU 25	FI191	Finland - Suomi	Satakunta	Aetsa	Finnish Chemicals Oy	240	S		By-Product
165	EU 25	FR222	France	Oise	Saint Leu d'Esserent	Praxair		SR	Pipeline to one customer	Merchant
166	EU 25	FR223	France	Somme	Harbonnières	Société des Produits Chimiques d'Harbonnières SA	17	CS/CK	Hydrochloric acid	By-Product
167	EU 25	FR223	France	Somme	Pont de Metz	Oxygene de Picardie SARL			small	Merchant
168	EU 25	FR232	France	Seine Maritime	Gonfreville L'Orcher	Total	268	Ethylene		By-Product
169	EU 25	FR232	France	Seine Maritime	Gonfreville L'Orcher	Total	235	Styrene		By-Product
170	EU 25	FR232	France	Seine Maritime	Notre Dame de Gravenchon	ExxonMobil Chemical	208	Ethylene		By-Product
171	EU 25	FR232	France	Seine Maritime	Port Jérôme	Air Liquide	1200	SMR	Feeds pipeline to supply neighbouring petrochemical plants	Merchant
172	EU 25	FR232	France	Seine Maritime	Port Jérôme	Esso	210	SMR	Refinery	Captive



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
173	EU 25	FR263	France	Saone et Loire	Gueugnon	Air Liquide	19	SMR	Supplies metallurgical company.	Merchant
174	EU 25	FR301	France	Nord	Dunkerque	Copenor GIE	187	Ethylene		By-Product
175	EU 25	FR301	France	Nord	La Madeleine	Rhodia	32	CS	Hydrochloric acid	By-Product
176	EU 25	FR301	France	Nord	Loos	Produits Chimiques de Loos SA	13	CS/CK		By-Product
177	EU 25	FR301	France	Nord	Waziers	Air Liquide	120	SMR or WE + LH2	Liquefaction capacity: 10.5 t/day	Merchant
178	EU 25	FR302	France	Pas de Calais	Isbergues	Air Liquide			Production shut down in 2002; filling station remained	Merchant
179	EU 25	FR413	France	Moselle	Carling St Avoird	Total	199	Styrene		By-Product
180	EU 25	FR413	France	Moselle	Carling St Avoird	Total	286	Ethylene		By-Product
181	EU 25	FR422	France	Haut Rhin	Chalampe	Linde	500	SR	On-site plant for Butachimie	Merchant
182	EU 25	FR422	France	Haut Rhin	Thann	Albermarle PPC	53	CS	hydrochloric acid	By-Product
183	EU 25	FR432	France	Jura	Tavaux	Solvay	278	CS		By-Product
184	EU 25	FR612	France	Gironde	Ambès	Eka Chemicals	115	S		By-Product
185	EU 25	FR615	France	Pyrénées-Atlantiques	Pardies	Pardies Acetiques SA, Acetex Chimie	512	Acetylene	Carbon monoxide is used mainly for acetic acid production	By-Product
186	EU 25	FR615	France	Pyrénées-Atlantiques	Lacq	Total	39	Ethylene		By-Product
187	EU 25	FR615	France	Pyrénées-Atlantiques	Lacq	Air Liquide	43	SMR	Supply to local chemical plant of Arkema	Merchant
188	EU 25	FR714	France	Isère	Jarrie	Arkema	116	CS + PSA	H <sub>2</sub> O <sub>2</sub> production.	Captive
189	EU 25	FR714	France	Isère	Jarrie	Arkema	190	CS		By-Product
190	EU 25	FR714	France	Isère	Jarrie	Total	142	S		By-Product
191	EU 25	FR714	France	Isère	Le Pont de Claix	Air Liquide	175	POX	On-site plant for Rhodia with carbon monoxide and hydrogen for use in phosgene production	Merchant
192	EU 25	FR714	France	Isère	Le Pont de Claix	Air Liquide	72	SMR		Merchant



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
193	EU 25	FR714	France	Isère	Le Pont de Claix	Rhodia	174	CS		By-Product
194	EU 25	FR716	France	Rhône	Feyzin	Association du Vapocraqueur	130	Ethylene		By-Product
195	EU 25	FR716	France	Rhône	Saint Fons	Air Liquide	360	SMR		Merchant
196	EU 25	FR717	France	Savoie	Saint Marcel	Metaux Speciaux	16	CS		By-Product
197	EU 25	FR821	France	Alpes-de-Haute- Provence	Saint Auban	Arkema	151	CS		By-Product
198	EU 25	FR824	France	Bouches du Rhône	Berre l'Etang	Shell Chemicals	263	SMR	Refinery	Captive
199	EU 25	FR824	France	Bouches du Rhône	Berre l'Etang	Société du Craqueur de Berre	252	Ethylene		By-Product
200	EU 25	FR824	France	Bouches du Rhône	Fos sur Mer	Linde	200	CS	Linked to Air Liquide's South- East pipeline	By-Product
201	EU 25	FR824	France	Bouches du Rhône	Lavéra	Air Liquide	600	SMR	Refinery	Merchant
202	EU 25	FR824	France	Bouches du Rhône	Lavéra	Arkema	248	CS		By-Product
203	EU 25	FR824	France	Bouches du Rhône	Lavéra	Naphtachimie SA	385	Ethylene		By-Product
204	EU 25	FR824	France	Bouches du Rhône	Lavéra	BP	850	SMR	Refinery	Captive
205	EU 25	GR253	Greece - Ellada	Korinthia	Agioi Theodoroi	Motor Oil (Hellas) Corinth Refineries SA	79	SMR + PSA	Refinery	Captive
206	EU 25	GR253	Greece - Ellada	Korinthia	Corinth	Motor Oil (Hellas) Corinth Refineries SA	65	SMR + PSA	Refinery	Captive
207	EU 25	GR122	Greece - Ellada	Thessaloniki	Diavata	Hellenic Petroleum S.A.	30	CS		By-Product
208	EU 25	GR122	Greece - Ellada	Thessaloniki	Thessaloniki	Eko Chemicals	10	Ethylene		By-Product
209	EU 25	GR300	Greece - Ellada	Attiki	Mandra	Linde		WE		Merchant
210	EU 25	GR300	Greece - Ellada	Attiki	Aspropyrgos	Hellenic Petroleum S.A.	252	SMR + PSA	Refinery	Captive



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
211	EU 25	GR300	Greece - Ellada	Attiki	Aspropyrgos	Hellenic Petroleum S.A.	250	SMR + PSA	Refinery	Captive
212	EU 25	HU101	Hungary - Magyarország	Budapest	Budapest	Budapesti Vegyiművek Rt.	8	CS	chlorine-alkaline manufacturing	By-Product
213	EU 25	HU101	Hungary - Magyarország	Budapest	Százhalombatta	MOL		SMR	Refinery	Captive
214	EU 25	HU101	Hungary - Magyarország	Budapest	Százhalombatta	MOL	960	SMR	Refinery	Captive
215	EU 25	HU213	Hungary - Magyarország	Veszprem	Peremarton	Kemira GrowHow			Ammonia	Captive
216	EU 25	HU311	Hungary - Magyarország	Borsod-Abauj-Zemplen	Kazincbarcika	BorsodChem	100	CS	chlorine-alkaline manufacturing; hydrochloric acid	By-Product
217	EU 25	HU311	Hungary - Magyarország	Borsod-Abauj-Zemplen	Kazincbarcika	Linde	90	SMR	Most H <sub>2</sub> -CO production supplied to BorsodChem Rt. for polymer production; announcement of a joint investment to increase H <sub>2</sub> production capacity to 220,000 m <sup>3</sup> /day	Captive + Merchant
218	EU 25	HU311	Hungary - Magyarország	Borsod-Abauj-Zemplen	Tiszaujvaros	MOL				Captive
219	EU 25	HU311	Hungary - Magyarország	Borsod-Abauj-Zemplen	Tiszaujvaros	TVK		SMR	Captive for polyethylene and polypropylene production; SMR from Linde technology	Captive
220	EU 25	IE021	Ireland	Dublin	Dublin	BOC	2.4	Electrolytic plant		Merchant
221	EU 25	IE025	Ireland	South-West	Fermoy	Micro-Bio Ltd.	4	CS	Hydrochloric acid	By-Product
222	EU 25	ITC11	Italy - Italia	Torino	Borgofranco d'Ivrea	Industrie Chimiche Di Borgofranco Srl	9	S		By-Product
223	EU 25	ITC11	Italy - Italia	Torino	Venaria-Reale	Air Liquide	24			Merchant



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
224	EU 25	ITC14	Italy - Italia	Verbano-Cusio-Ossola	Pieve Vergonte	Air Products		PSA recovery from a chemical plant		Merchant
225	EU 25	ITC14	Italy - Italia	Verbano-Cusio-Ossola	Pieve Vergonte	Tessenderlo Italia	31	CS		By-Product
226	EU 25	ITC15	Italy - Italia	Novara	Novara	Radici Chimica SpA	88		Adipic acid by hydrogenation of phenol	Captive
227	EU 25	ITC16	Italy - Italia	Cuneo	Cuneo	SOL SpA	8	PSA		Merchant
228	EU 25	ITC18	Italy - Italia	Alessandria	Novi Ligure	SIAD	24			Merchant
229	EU 25	ITC33	Italy - Italia	Genova	Genova	Ansaldo	22	SMR		Merchant
230	EU 25	ITC4A	Italy - Italia	Cremona	Cremona	Tamoil	156	PSA	Refinery	Captive
231	EU 25	ITC4B	Italy - Italia	Mantova	Mantova	Air Products	17	SMR	On-site supply	Merchant
232	EU 25	ITC4B	Italy - Italia	Mantova	Mantova	Air Products	425	SMR	On-site supply for Italia Energia E.	Merchant
233	EU 25	ITC4B	Italy - Italia	Mantova	Mantova	EniChem	362	Styrene		By-Product
234	EU 25	ITC4B	Italy - Italia	Mantova	Mantova	Air Products		SMR		Merchant
235	EU 25	ITC45	Italy - Italia	Milano	Macherio	SIR Industriale SpA	3			Captive
236	EU 25	ITC46	Italy - Italia	Bergamo	Osio Sopra	SIAD	13			Merchant
237	EU 25	ITC47	Italy - Italia	Brescia	Brescia	Industrie Chimiche Caffaro	32	CS	Most Captive for hydrochloric acid and some sales	By-Product
238	EU 25	ITC47	Italy - Italia	Brescia	Brescia	Industrie Chimiche Caffaro	21	S		By-Product
239	EU 25	ITC48	Italy - Italia	Pavia	Sannazaro de Burgondi	Gela	1056	SR Naphta	Refinery	Captive
240	EU 25	ITD35	Italy - Italia	Venezia	Porto Marghera	Crion	12	SMR	Refinery	Captive
241	EU 25	ITD35	Italy - Italia	Venezia	Porto Marghera	EniChem	150	CS	Captive for hydrochloric acid	By-Product
242	EU 25	ITD35	Italy - Italia	Venezia	Porto Marghera	EniChem	540			Captive



ID	Zone	NUTS 3	Country (= NUTS level 0)	Region (= NUTS level 3)	Plant site	Owner	Capacity [10 <sup>3</sup> m <sup>3</sup> /day]	Process / source	Current Use / Remarks	Availability
243	EU 25	ITD35	Italy - Italia	Venezia	Porto Marghera	Polimeri Europa	255	Ethylene		By-Product
244	EU 25	ITD35	Italy - Italia	Venezia	Porto Marghera	Syndial SA	148	CS		By-Product
245	EU 25	ITD35	Italy - Italia	Venezia	Venice	Eni	226		Refinery	Captive
246	EU 25	ITD43	Italy - Italia	Gorizia	Torviscosa	Industrie Chimiche Caffaro	50	CS		By-Product
247	EU 25	ITD56	Italy - Italia	Ferrara	Ferrara	Crion		PSA	Ammonia	Captive
248	EU 25	ITD57	Italy - Italia	Ravenna	Ravenna	Rivoira SpA, majority owned by Praxair, Inc.	12	POX of natural gas + PSA purificatio n		Merchant
249	EU 25	ITD57	Italy - Italia	Ravenna	Ravenna	Rivoira SpA, majority owned by Praxair, Inc.	72			Merchant
250	EU 25	ITD57	Italy - Italia	Ravenna	Ravenna	SOL SpA	12	SMR		Merchant
251	EU 25	ITE16	Italy - Italia	Livorno	Rosignano	Solvay	92	CS	Captive for hydrochloric acid, hydrogen peroxide	By-Product
252	EU 25	ITE17	Italy - Italia	Pisa	Pisa	SOL SpA		Laborator y		Merchant
253	EU 25	ITE17	Italy - Italia	Pisa	Saline di Volterra	Altair Chimica SpA	20	CS/CK	Captive for hydrochloric acid	By-Product
254	EU 25	ITE32	Italy - Italia	Ancona	Falconara Marittima	Anonima Petroli Italiana S.p.A.	110	SMR	Refinery	Captive
255	EU 25	ITE32	Italy - Italia	Ancona	Falconara Marittima	Api Energia SpA	96	Refinery off-gas.	Refinery	Captive
256	EU 25	ITE32	Italy - Italia	Ancona	Falconara Marittima	Api Energia SpA	400	SMR		Merchant
257	EU 25	ITE43	Italy - Italia	Roma	Nera Montoro	Terni Industrie Chimiche SpA	25	PSA	Captive for chemicals	Captive
258	EU 25	ITF13	Italy - Italia	Pescara	Bussi sul Tirino	Ausimont SpA	62	CS	Captive for hydrochloric acid, hydrogen peroxide	By-Product



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259	EU 25	ITF13	Italy - Italia	Pescara	Bussi sul Tirino	Solvay	58	CS		By-Product
260	EU 25	ITF14	Italy - Italia	Chieti	San Salvo	Rivoira SpA, majority owned by Praxair, Inc.	3.8	SMR		Merchant
261	EU 25	ITF35	Italy - Italia	Salerno	Salerno	SOL SpA	4	SMR		Merchant
262	EU 25	ITF43	Italy - Italia	Taranto	Taranto	Gela	1038	SR Naphta	Refinery	Captive
263	EU 25	ITF43	Italy - Italia	Taranto	Taranto	Italiana Petroli SpA; 80% owned by ERG SpA [Italy]	300	SMR	Refinery	Captive
264	EU 25	ITF44	Italy - Italia	Brindisi	Brindisi	EniChem	14			Captive
265	EU 25	ITF44	Italy - Italia	Brindisi	Brindisi	Polimeri Europa	213	Ethylene		By-Product
266	EU 25	ITF52	Italy - Italia	Matera	Ferrandina	Sapio Srl, subsidiary of Air Products	25	SMR		Merchant
267	EU 25	ITG13	Italy - Italia	Messina	Milazzo	Linde	1300	SMR	On-site supply of Raffineria di Milazzo	Merchant
268	EU 25	ITG13	Italy - Italia	Messina	Milazzo	Raffineria di Milazzo SpA.	1300		Refinery	Captive
269	EU 25	ITG13	Italy - Italia	Messina	Milazzo	Raffineria di Milazzo SpA.	370		Refinery	Captive
270	EU 25	ITG15	Italy - Italia	Caltanissetta	Gela	Praoil	447	POX	Refinery	Captive
271	EU 25	ITG15	Italy - Italia	Caltanissetta	Gela	Praoil	210		Refinery	Captive
272	EU 25	ITG15	Italy - Italia	Caltanissetta	Gela	Polimeri Europa	130	Ethylene		By-Product
273	EU 25	ITG17	Italy - Italia	Catania	Catania	Air Liquide	7	SMR		Merchant
274	EU 25	ITG19	Italy - Italia	Siracusa	Augusta	Esso	42	Ethylene		By-Product
275	EU 25	ITG19	Italy - Italia	Siracusa	Melilli	ERG	450	SR Naphta	Refinery	Captive



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276	EU 25	ITG19	Italy - Italia	Siracusa	Priolo	Air Liquide	650	SMR	Over-the-fence supply to ERG as well as other customers in the Priolo area; in addition, Air Liquide will invest in a pipeline network in the Priolo area	Merchant
277	EU 25	ITG19	Italy - Italia	Siracusa	Priolo	ISAB SpA	534	SR Naphta	Refinery	Captive
278	EU 25	ITG19	Italy - Italia	Siracusa	Priolo	EniChem	135	CS/CK		By-Product
279	EU 25	ITG19	Italy - Italia	Siracusa	Priolo	Polimeri Europa	427	Ethylene		By-Product
280	EU 25	ITG19	Italy - Italia	Siracusa	Priolo	Syndial SA	151	CS		By-Product
281	EU 25	ITG21	Italy - Italia	Sassari	Porto Torres	EniChem	71	CS		By-Product
282	EU 25	ITG21	Italy - Italia	Sassari	Porto Torres	Polimeri Europa	138	Ethylene		By-Product
283	EU 25	ITG24	Italy - Italia	Cagliari	Assemini	EniChem	63	CS	Captive for hydrochloric acid	By-Product
284	EU 25	ITG24	Italy - Italia	Cagliari	Assemini	Syndial SA	126	CS		By-Product
285	EU 25	ITG24	Italy - Italia	Cagliari	Sarroch	Saras SpA Raffinerie Sarde	752	SR Naphta + PSA	Refinery	Captive
286	EU 25	ITG24	Italy - Italia	Cagliari	Sarroch	Sarlux SpA; joint- venture between Saras SpA and Enron Corp.	480	Tar gasificatio n	Hydrogen supply to Saras for refining operations	Captive
287	EU 25	LT008	Lithuania - Lietuva	Telsiu apskritis	Mazeikiai	JSC Mazeikiu Nafta	1769	SMR	Refinery	Captive
288	EU 25	NL112	Netherlands - Nederland	Delfzijl en omgeving	Delfzijl	Akzo Nobel	83	CS	Partly used to produce monochloro-ethanoic acid; 25% sold to Teijin-Twaron; 66% taken by Delesto (JV with Nuon, cogeneration units 50+200 MWe)	By-Product
289	EU 25	NL213	Netherlands - Nederland	Twente	Hengelo	Akzo Nobel	55	CS	To be closed in July 2006	By-Product



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290	EU 25	NL326	Netherlands - Nederland	Groot-Amsterdam	Amsterdam	Air Products			Previously owned by AGA Gas BV	Merchant
291	EU 25	NL332	Netherlands - Nederland	Agglomeratie's- Gravenhage	Botlek-Rotterdam	Akzo Nobel	500	CS	60% sold to Air Products under a contract until 2013; 40% currently burnt in Akzo Nobel's cogeneration unit on-site (100% owned by Akzo); after debottlenecking the production should increase by 10%	By-Product
292	EU 25	NL332	Netherlands - Nederland	Agglomeratie's- Gravenhage	Botlek-Rotterdam	ExxonMobil Chemical	680	SMR	Refinery	Captive
293	EU 25	NL332	Netherlands - Nederland	Agglomeratie's- Gravenhage	Botlek-Rotterdam	Lyondell Chemical	383	Styrene		By-Product
294	EU 25	NL332	Netherlands - Nederland	Agglomeratie's- Gravenhage	Rotterdam - Pernis	Air Products	17	SMR		Merchant
295	EU 25	NL332	Netherlands - Nederland	Agglomeratie's- Gravenhage	Rotterdam-Pernis	Shell Chemicals	1551	SMR, PSA	Refinery	Captive
296	EU 25	NL335	Netherlands - Nederland	Groot-Rijnmond	Europoort	Kuwait Petroleum Europoort BV	57	PSA	Refinery	Captive
297	EU 25	NL335	Netherlands - Nederland	Groot-Rijnmond	Rozenburg	Air Liquide	288	SMR		Merchant
298	EU 25	NL335	Netherlands - Nederland	Groot-Rijnmond	Rozenburg	Air Liquide	326	ATR		Merchant
299	EU 25	NL335	Netherlands - Nederland	Groot-Rijnmond	Rozenburg	Air Products	487	SMR + LH2	Liquefaction capacity: 5.4 t/day	Merchant
300	EU 25	NL341	Netherlands - Nederland	Zeeuwsch- Vlaanderen	Terneuzen	Dow	885	Ethylene		By-Product
301	EU 25	NL341	Netherlands - Nederland	Zeeuwsch- Vlaanderen	Terneuzen	Dow	603	Styrene		By-Product
302	EU 25	NL342	Netherlands - Nederland	Overig Zeeland	Bergen op Zoom	Air Liquide	744	SMR		Merchant



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303	EU 25	NL342	Netherlands - Nederland	Overig Zeeland	Bergen op Zoom	Air Liquide	25	SMR	Supplies Lyondell Exxon and feeds pipeline	Merchant
304	EU 25	NL342	Netherlands - Nederland	Overig Zeeland	Bergen op Zoom	General Electric Plastics	20		Hydrogen and carbon monoxide are consumed for phosgene	Captive
305	EU 25	NL342	Netherlands - Nederland	Overig Zeeland	Bergen op Zoom	General Electric Plastics	64	CS		By-Product
306	EU 25	NL342	Netherlands - Nederland	Overig Zeeland	Middelburg	Hercules International Ltd	17	SMR, PSA	Hydrogenated resins	Captive
307	EU 25	NL342	Netherlands - Nederland	Overig Zeeland	Vlissingen	Total	1756	SMR, PSA	Refinery	Captive
308	EU 25	NL342	Netherlands - Nederland	Overig Zeeland	Vlissingen	Total	190	SMR, PSA		Captive
309	EU 25	NL413	Netherlands - Nederland	Noordoost-Noord- Brabant	Moerdijk	Shell Chemicals	468	Ethylene		By-Product
310	EU 25	NL413	Netherlands - Nederland	Noordoost-Noord- Brabant	Moerdijk	Basell	341	Styrene		By-Product
311	EU 25	NL413	Netherlands - Nederland	Noordoost-Noord- Brabant	Moerdijk	Shell Chemicals	265	Styrene		By-Product
312	EU 25	NL423	Netherlands - Nederland	Zuid-Limburg	Geleen	DSM		SMR		Captive
313	EU 25	NL423	Netherlands - Nederland	Zuid-Limburg	Geleen	DSM	16	Styrene		By-Product
314	EU 25	NL423	Netherlands - Nederland	Zuid-Limburg	Geleen	Sabic EuroPetrochemicals	643	Ethylene		By-Product
315	EU 25	NL423	Netherlands - Nederland	Zuid-Limburg	Geleen	Sabic EuroPetrochemicals		SR Naphta	Captive use and sold to other companies in Geleen	Captive
316	EU 25	PL121	Poland - Polska	Ciechanowsko-plocki	Plock	Petrochemia Plock S.A.	110		Also recovers hydrogen for merchant market	Captive + Merchant
317	EU 25	PL211	Poland - Polska	Krakowsko-tarnowski	Tarnow	Zaklady Azotowe	16	CS	chlorine-alkaline manufacturing, cyclohexane	Captive



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318	EU 25	PL226	Poland - Polska	Centralny slaski	Chorzow	Metanol Sp.z.o.o.			Ammonia, oxo chemicals, methanol	Captive
319	EU 25	PL313	Poland - Polska	Lubelski	Pulawy	Zaklady Azotowe	85		Ammonia, hydrogen peroxide and cyclohexane	Captive
320	EU 25	PL322	Poland - Polska	Krosniensko- przemyski	Jedlicze	Lurgi Oel-Fas Chemie/Jedlicze Oil refinery	24		Refinery	Captive
321	EU 25	PL511	Poland - Polska	Jeleniogorsko- walbrzyski	Gorlitze	Rafineria Nafty 'Glimar' SA			Basic oils and pharmaceutical oils	Captive
322	EU 25	PL513	Poland - Polska	Wroclawski	Brzeg Dolny	Zaklady Chemiczne	80	CS	chlorine-alkaline manufacturing	Captive
323	EU 25	PL611	Poland - Polska	Bydgoski	Bydgoszcz	Zaklady Chemiczne	40	CS	chlorine-alkaline manufacturing; TDI	Captive
324	EU 25	PL612	Poland - Polska	Torunsko-wloclawski	Wloclawek	Anwil S.A.	144	CS	chlorine-alkaline manufacturing	By-Product
325	EU 25	PL633	Poland - Polska	Gdansk-Gdynia-Sopot	Gdansk	Rafineria Gdansk			Refinery	Captive
326	EU 25	PT161	Portugal	Baixo Vouga	Estarreja	Uniao Industrial Textil e Quimica SA - UNITECA	9			By-Product
327	EU 25	PT161	Portugal	Baixo Vouga	Estarreja	Air Liquide	76	SMR		Merchant
328	EU 25	PT161	Portugal	Baixo Vouga	Estarreja	Air Liquide	120	SMR	Hydrogen supplied primarily to QUIMIGAL group for the production of aniline	Merchant
329	EU 25	PT161	Portugal	Baixo Vouga	Estarreja	Uniao Industrial Textil e Quimica SA - UNITECA	50	CS		By-Product
330	EU 25	PT171	Portugal	Grande Lisboa	Lisboa	GDP				Merchant
331	EU 25	PT171	Portugal	Grande Lisboa	Povoa de Santa Iria	Solvay	39	CS	Hydrochloric acid and hydrogen peroxide	By-Product
332	EU 25	PT171	Portugal	Grande Lisboa	Povoa de Santa Iria	Solvay	28	S		By-Product
333	EU 25	PT181	Portugal	Alentejo Litoral	Sines	Borealis	187	Ethylene		By-Product



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334	EU 25	PT181	Portugal	Alentejo Litoral	Sines	Petrogal	1550	SR Naphta	Refinery	Captive
335	EU 25	SE0A2	Sweden - Sverige	Västra Götalands län	Bohus	Eka Chemicals	79	CS/CK	Hydrochloric acid and hydrogen peroxide	By-Product
336	EU 25	SE0A2	Sweden - Sverige	Västra Götalands län	Göteborg	Preem Raffinaderi AB SCANRAFF	946	Cryogenic	Refinery	Captive
337	EU 25	SE0A2	Sweden - Sverige	Västra Götalands län	Lysekil	Scandinaviska Raffinaderi AB	255	Cryogenic	Refinery	Captive
338	EU 25	SE0A2	Sweden - Sverige	Västra Götalands län	Stenungsund	Norsk Hydro	89	CS		By-Product
339	EU 25	SE0A2	Sweden - Sverige	Västra Götalands län	Stenungsund	Borealis	318	Ethylene		By-Product
340	EU 25	SE010	Sweden - Sverige	Stockholms län	Nynashamm	AB Nynas Petroleum	120	SR Naphta	Refinery	Captive
341	EU 25	SE010	Sweden - Sverige	Stockholms län	Skoghall	Akzo Nobel	60	CS	Used to produce monochloro-acetic acid; 50% is used for the generation of steam, 50% would be available for sale	By-Product
342	EU 25	SE025	Sweden - Sverige	Västmanlands län	Fagersta	Linde	7			Merchant
343	EU 25	SE044	Sweden - Sverige	Skåne län	Halmstad	Linde	6			Merchant
344	EU 25	SE044	Sweden - Sverige	Skåne län	Helsingborg	Kemira Kemi AB	96		Hydrogen peroxide	Captive
345	EU 25	SE062	Sweden - Sverige	Dalarnas län	Borlange	Linde	5			Merchant
346	EU 25	SE071	Sweden - Sverige	Västernorrlands län	Sundsvall	Eka Chemicals	90	S	Hydrogenation and fuel.	By-Product
347	EU 25	SE072	Sweden - Sverige	Jämtlands län	Alby	Eka Chemicals	144		Hydrogen peroxide	Captive
348	EU 25	SE072	Sweden - Sverige	Jämtlands län	Alby	Eka Chemicals	124	S	Hydrogen peroxide	By-Product
349	EU 25	SE0	Sweden - Sverige		Others	Linde	3			Merchant
350	EU 25	SI005	Slovenia - Slovenija	Zasavska	Hrastnik	Tovarna Kemicnih Izdelk	8	CS	chlorine-alkaline manufacturing	Captive
351	EU 25	SK010	Slovakia - Slovenska Republika	Bratislavsky kraj	Bratislava	Slovnaft a.s., MOL group (Hungary)	916	SMR	Refinery	Captive



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352	EU 25	SK022	Slovakia - Slovenska Republika	Trenciansky kraj	Novaky	Novacke Chemicke Zavody a.s.	55	CS	chlorine-alkaline manufacturing	By-Product
353	EU 25	UKC11	United Kingdom	Hartlepool & Stockton-on-Tees	North Tees	BOC	978	SMR	High-purity hydrogen is supplied by pipeline to Huntsman Feedstock for PU raw materials and aromatics production	Merchant
354	EU 25	UKC12	United Kingdom	South Teesside	Wilton	Huntsman Petrochemicals Ltd.	450	Ethylene	Cyclohexane, nitrobenzene	By-Product
355	EU 25	UKC12	United Kingdom	South Teesside	Wilton	Air Products	15	SMR	Was built to supply DuPont's nearby nylon manufacturing facility and ICI's nearby chemical facility	Merchant
356	EU 25	UKD11	United Kingdom	West Cumbria	Whitehaven	Albright & Wilson UK Ltd	26	SMR		Captive
357	EU 25	UKD21	United Kingdom	Halton and Warrington	Runcorn	INEOS Chlor	546	CS/CK	Pipeline and merchant marketed by Linde	By-Product
358	EU 25	UKD22	United Kingdom	Cheshire CC	Sandbach	Albion Chemicals	63	CS		By-Product
359	EU 25	UKD22	United Kingdom	Cheshire CC	Ellesmere Port	Shell Chemicals		SMR	Refinery	Captive
360	EU 25	UKD22	United Kingdom	Cheshire CC	Ellesmere Port	Shell Chemicals	23	Ethylene		By-Product
361	EU 25	UKD22	United Kingdom	Cheshire CC	Ellesmere Port	The Associated Oxcel Company Ltd	26	CS	Mostly captive use, small volume to Hydrogen Supplies Ltd.	By-Product
362	EU 25	UKD22	United Kingdom	Cheshire CC	Ellesmere Port	The Associated Oxcel Company Ltd	32	CS	Mostly captive use, small volume to Hydrogen Supplies Ltd.	By-Product
363	EU 25	UKD22	United Kingdom	Cheshire CC	Sandbach	Air Products	12		from Hays chemical; 3.5t LH2 storage as back-up tank	Merchant
364	EU 25	UKD22	United Kingdom	Cheshire CC	Sandbach	Hays Chemical Distribution	63	CS	Filling station of Air Products; Norwich site closed down in 2001	By-Product
365	EU 25	UKD51	United Kingdom	East Merseyside	St Helens	BOC	55	SMR	Supply to Pilkington float glass production	Merchant



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366	EU 25	UKE11	United Kingdom	City of Kingston upon Hull	Hull	BP	576	POX	Syngas for oxo chemicals	Captive
367	EU 25	UKE13	United Kingdom	North and North East Lincolnshire	Killingholme	ConocoPhillips	495	PSA	Refinery	Captive
368	EU 25	UKE42	United Kingdom	Leeds	Castleford	BOC	26	SMR	Merchant and pipeline	Merchant
369	EU 25	UKE42	United Kingdom	Leeds	Castleford	C6 Solutions Ltd	38		Supply to BOC	By-Product
370	EU 25	UKF11	United Kingdom	Derby	Chesterfield	Rhodia	24	CS	Hydrochloric acid and supply to BOC	By-Product
371	EU 25	UKH32	United Kingdom	Thurrock	Purfleet	Air Products	12	SR	from Van den Bergh Oils	Merchant
372	EU 25	UKJ33	United Kingdom	Hampshire CC	Hythe Southampton	Enichem	36	Styrene		By-Product
373	EU 25	UKJ33	United Kingdom	Hampshire CC	Fawley	ExxonMobil Chemical	65	Ethylene		By-Product
374	EU 25	UKJ33	United Kingdom	Hampshire CC	Fawley	ExxonMobil Chemical	1358		Refinery	Captive
375	EU 25	UKL14	United Kingdom	South West Wales	Pembroke	Pembroke Cracking Company	25	SR Propane	Refinery	Captive
376	EU 25	UKL16	United Kingdom	Gwent Valleys	Llanwern	Air Products	63		Plant is on British Steel Corp. site	Merchant
377	EU 25	UKL16	United Kingdom	Gwent Valleys	Llanwern	Air Products	5	COG	Source of coke oven gas from steel plant with over-the-fence supply and sales; closed in 2002	Merchant
378	EU 25	UKL17	United Kingdom	Bridgend and Neath Port Talbot	Margam	BOC	31	SMR	Two plants operate at this location; merchant and pipeline sales	Merchant
379	EU 25	UKL21	United Kingdom	Monmouthshire and Newport	Llanwern	British Steel Corporation		COG	Supply to Air Products	By-Product
380	EU 25	UKL22	United Kingdom	Cardiff and Vale of Glamorgan	Barry	BOC	12	SMR	Feeds BOC pipeline	Merchant
381	EU 25	UKM22	United Kingdom	Clackmannanshire and Fife	Mossmorran	ExxonMobil Chemical	416	Ethylene		By-Product



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382	EU 25	UKM26	United Kingdom	Falkirk	Grangemouth	BP	531	Ethylene		By-Product
383	EU 25	UKM26	United Kingdom	Falkirk	Grangemouth	BP	1388		Refinery	Captive
384	EU 25	UKM33	United Kingdom	East Ayrshire & North Ayrshire	Dalry	BOC	24		Merchant gas BOC pipeline to Roche Pharma-ceuticals	Merchant
385	EU 25	UKM35	United Kingdom	Inverclyde	Greenock	Air Products	10		Plant built on site of national Semiconductor; high purity hydrogen supplied by pipeline over the fence	Merchant
386	EFTA	CH012	Switzerland - Schweiz - Suisse - Svizzera	Valais	Collombey	Tamoil	790	SR Naphta	Refinery	Captive
387	EFTA	CH012	Switzerland - Schweiz - Suisse - Svizzera	Valais	Massongex	Air Liquide				Merchant
388	EFTA	CH012	Switzerland - Schweiz - Suisse - Svizzera	Valais	Monthey	Syngenta S.A.	18	CS	Filling station of carbagas	By-Product
389	EFTA	CH012	Switzerland - Schweiz - Suisse - Svizzera	Valais	Visp	Lonza AG	16	Ethylene		By-Product
390	EFTA	CH012	Switzerland - Schweiz - Suisse - Svizzera	Valais	Visp	Lonza AG	240	Naptha cracker / HCN	Partly captively used for chemicals	Captive
391	EFTA	CH022	Switzerland - Schweiz - Suisse - Svizzera	Fribourg	Domdidier	Air Liquide				Merchant
392	EFTA	CH023	Switzerland - Schweiz - Suisse - Svizzera	Solothurn	Luterbach	Borregaard Schweiz	9	CS	Hydrochloric acid and gas compressed and sold to Pangas (Linde)	By-Product
393	EFTA	CH023	Switzerland - Schweiz - Suisse - Svizzera	Solothurn	Luterbach	Borregaard Schweiz	2	S		By-Product
394	EFTA	CH024	Switzerland - Schweiz - Suisse - Svizzera	Neuchâtel	Cressier	Petroplus Refining Cressier, SA	187	SMR	Refinery	Captive
395	EFTA	CH032	Switzerland - Schweiz - Suisse - Svizzera	Basel-Landschaft	Pratteln	SF-Chem	22	CS	Mostly captive use, few sales to chemical companies; shut down in July 2004	By-Product



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396	EFTA	CH033	Switzerland - Schweiz - Suisse - Svizzera	Aargau	Lenzburg	Sauerstoffwerke Lenzburg AG, owned 100% by Messer Group	12	SMR	Water electrolysis group shut down in 2000	Merchant
397	EFTA	CH033	Switzerland - Schweiz - Suisse - Svizzera	Aargau	Zurzach	Carbagas, owned by Air Liquide	27	SMR	Replaces hydrogen from CS electrolysis; shut down in 2004	Merchant
398	EFTA	CH033	Switzerland - Schweiz - Suisse - Svizzera	Aargau	Zurzach	Solvay	40	CS	Hydrochloric acid and sales to chemical companies	By-Product
399	EFTA	CH04	Switzerland - Schweiz - Suisse - Svizzera	Zürich	Winterthur	Linde		WE	Plant will likely be shut down on the medium term	Merchant
400	EFTA	IS	Iceland - Ísland	Ísland	Reykjavik	Aburdarverksmidjan hf		WE	30,000 m <sup>3</sup> /hr production; shut down in 2001	Merchant
401	EFTA	IS	Iceland - Ísland	Ísland	Reykjavik	Skeljungur hf (Shell Iceland)	69	WE	Filling station for vehicles	Merchant
402	EFTA	NO031	Norway - Norge	Østfold	Sarpsborg	Borregaard Industries	33	CS	Hydrochloric acid	By-Product
403	EFTA	NO034	Norway - Norge	Telemark	Rafnes-Stathelle	Norsk Hydro	197	CS		By-Product
404	EFTA	NO034	Norway - Norge	Telemark	Rafnes	Noretyl	234	Ethylene		By-Product
405	EFTA	NO034	Norway - Norge	Telemark	Rjukan	Norsk Hydro		WE	Gases and chemicals division	Merchant
406	EFTA	NO052	Norway - Norge	Sogn og Fjordane	Svelgen	Elkem ASA, Silicon Division	9	CS		By-Product
407	EFTA	NO052	Norway - Norge	Sogn og Fjordane	Vadheim	A/S Vadheim Elektrochemiske Fabriker	11	S		By-Product
408	EFTA	NO071	Norway - Norge	Nordland	Mo-I-Rana	Eka Chemicals	85	S	Fuel and external sales	By-Product
409	CC	BG231	Bulgaria	Burgas	Burgas	Neftochi	290	SMR	Refinery	Captive ?
410	CC	HR032	Croatia - Hrvatska	Primorsko-Goranska zupanija	Krk Island	INA ?			chlorine-alkaline manufacturing	By-Product ?
411	CC	HR032	Croatia - Hrvatska	Primorsko-Goranska zupanija	Rijeka	INA Industrija Nafte dd	1200	SMR	Refinery	Captive ?



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412	CC	HR016	Croatia - Hrvatska	Sisačko-moslavačka zupanija	Sisak	INA Industrija Nafted	1000	SMR	Refinery	Captive ?
413	CC	HR036	Croatia - Hrvatska	Splitsko-Dalmatinska zupanija	Kastel Sucurac	Jugovinil		CS	chlorine-alkaline manufacturing	By-Product
414	CC	RO031	Romania	Arges	Pitesti	Arpechim SA	42		Refinery	Captive ?
415	CC	RO036	Romania	Prahova	Ploiesti	Astra S.A.	59		Refinery	Captive ?
416	CC	RO011	Romania	Bacau	Borzesti	Chimcomplex	56	CS	chlorine-alkaline manufacturing	By-Product
417	CC	RO021	Romania	Braila	Braila	Grupul Industrial de Petrochimie	4	CS	chlorine-alkaline manufacturing	By-Product
418	CC	RO045	Romania	Valcea	Rimnicu-Vilcea	Oltchim	180	CS	chlorine-alkaline manufacturing	By-Product
419	CC	RO036	Romania	Prahova	Ploiesti	Petrotel SA	121		Refinery	Captive ?
420	CC	TR	Turkey - Turkiye				6100		combined capacities	
421	EU 25	AT312	Austria - Österreich	Linz-Wels	Linz	DSM	758		Ammonia	Captive
422	EU 25	AT312	Austria - Österreich	Linz-Wels	Linz	DSM	1704		Ammonia	Captive
423	EU 25	BE211	Belgium - Belgique - België	Antwerpen	Antwerpen	BASF	2814		Ammonia	Captive
424	EU 25	BE323	Belgium - Belgique - België	Arr. Mons	Tertre	Kemira SA	1650		Ammonia	Captive
425	EU 25	FR232	France	Seine Maritime	Le Grand Quevilly	Grande Paroisse	1677		Ammonia	Captive
426	EU 25	FR102	France	Seine-et-Marne	Nangis	Grande Paroisse	1650		Ammonia	Captive
427	EU 25	FR623	France	Haute-Garonne	Toulouse	Grande Paroisse	1704		Ammonia	Captive
428	EU 25	FR301	France	Nord	Waziers	Grande Paroisse	812		Ammonia	Captive
429	EU 25	FR232	France	Seine Maritime	Gonfreville L'Orcher	Yara	1569		Ammonia	Captive
430	EU 25	FR615	France	Pyrénées-Atlantiques	Pardies	Yara	676		Ammonia	Captive
431	EU 25	FR422	France	Haut Rhin	Ottmarshein	Produits et Engrais Chimiques du Rhin	974		Ammonia	Captive



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432	EU 25	DE126	Germany - Deutschland	Ludwigshafen am Rhein, Kreisfreie Stadt	Ludwigshafen	BASF	1894		Ammonia	Captive
433	EU 25	DE126	Germany - Deutschland	Ludwigshafen am Rhein, Kreisfreie Stadt	Ludwigshafen	BASF	2002		Ammonia	Captive
434	EU 25	DE418	Germany - Deutschland	Uckermark	Schwedt	Dia Chemie Anlagen	758		Ammonia	Captive
435	EU 25	DEA1D	Germany - Deutschland	Neuss	Dormagen	EC Erdolchemie	1461		Ammonia	Captive
436	EU 25	DEF05	Germany - Deutschland	Dithmarschen	Brunsbüttel	Yara	3030		Ammonia	Captive
437	EU 25	DED32	Germany - Deutschland	Delitzsch	Wittenberg Piesteritz	SKW Stickstoffwerke	4816		Ammonia	Captive
438	EU 25	DEA32	Germany - Deutschland	Gelsenkirchen, Kreisfreie Stadt	Gelsenkirchen	Veba Oel	1488		Ammonia	Captive
439	EU 25	GR122	Greece - Ellada	Thessaloniki	Thessaloniki	Eko Chemicals	649		Ammonia	Captive
440	EU 25	GR115	Greece - Ellada	Kavala	Nea Karvali	Phosphoric Fertilizers Industry	758		Ammonia	Captive
441	EFTA	IS	Iceland - Ísland	Ísland	Reykjavik	Aburðarverksmiðjan hf	54		Ammonia	Captive
442	EU 25	IE025	Ireland	South-West	Marino Point	Irish Fertilizer Industries	2516		Ammonia	Captive
443	EU 25	ITD56	Italy - Italia	Ferrara	Ferrara	Yara	2570		Ammonia	Captive
444	EU 25	NL423	Netherlands - Nederland	Zuid-Limburg	Geleen	DSM	4329		Ammonia	Captive
445	EU 25	NL341	Netherlands - Nederland	Zeeuwsch- Vlaanderen	Sluiskil	Yara	1650		Ammonia	Captive
446	EU 25	NL341	Netherlands - Nederland	Zeeuwsch- Vlaanderen	Sluiskil	Yara	2570		Ammonia	Captive



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447	EU 25	NL341	Netherlands - Nederland	Zeeuwsch- Vlaanderen	Sluiskil	Yara	2868		Ammonia	Captive
448	EFTA	NO034	Norway - Norge	Telemark	Porsgrunn	Norsk Hydro	2164		Ammonia	Captive
449	EU 25	PT172	Portugal	Península de Setúbal	Lavadrio Barreiro	Quimica de Portugal	1380		Ammonia	Captive
450	EU 25	ES615	Spain - España	Huelva	Huelva	Fertiberia	1786		Ammonia	Captive
451	EFTA	CH012	Switzerland - Schweiz - Suisse - Svizerra	Valais	Visp	Lonza AG	189		Ammonia	Captive
452	EU 25	UKD22	United Kingdom	Cheshire CC	Inces Marshes	Kemira Ince	1461		Ammonia	Captive
453	EU 25	UKE11	United Kingdom	City of Kingston upon Hull	Hull	Kemira Ince	1109		Ammonia	Captive
454	EU 25	UKE12	United Kingdom	East Riding of Yorkshire	Billingham	Terra Nitrogen	2056		Ammonia	Captive
455	EU 25	UKG12	United Kingdom	Worcestershire	Sevenside	Terra Nitrogen	1353		Ammonia	Captive
456	CC	BG131	Bulgaria	Varna	Varna / Poveyanovo	Agrobiochim	893		Ammonia	Captive
457	CC	BG113	Bulgaria	Vratsa	Vratsa	Agrobiochim	1786		Ammonia	Captive
458	CC	BG223	Bulgaria	Haskovo	Dimitrovgrad	Neochim	2002		Ammonia	Captive
459	EU 25	CZ042	Czech Republic - Ceska Republika	Ustecky kraj	Litvínov	Chemopetrol	1082		Ammonia	Captive
460	EU 25	SK010	Slovakia - Slovenska Republika	Bratislavsky kraj	Sala	Dusikarna Slovensko	1623		Ammonia	Captive
461	EU 25	HU213	Hungary - Magyarország	Veszprem	Petfurdo	Nitrogenmurek	1677		Ammonia	Captive
462	EU 25	PL520	Poland - Polska	Opolski	Kedzierzyn	Zaklady Azotowe	1650		Ammonia	Captive
463	EU 25	PL313	Poland - Polska	Lubelski	Pulawy	Zaklady Azotowe	4329		Ammonia	Captive
464	EU 25	PL211	Poland - Polska	Krakowsko-tarnowski	Tarnow	Zaklady Azotowe	730		Ammonia	Captive
465	EU 25	PL612	Poland - Polska	Torunsko-wloclawski	Wloclawek	Zaklady Azotowe	2191		Ammonia	Captive
466	EU 25	PL421	Poland - Polska	Szczecinski	Szczecin	Zaklady Chemiczne	2218		Ammonia	Captive



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467	EU 25		Romania		Slobozia	Amonil	2651		Ammonia	Captive
468	EU 25	RO014	Romania	Neamt	Piatra Neamt	Azochim	1461		Ammonia	Captive
469	EU 25	RO075	Romania	Mures	Tirgu Mures	Azomures	2651		Ammonia	Captive
470	EU 25	RO041	Romania	Dolj	Craiova	Dolj Chim	2651		Ammonia	Captive
471	EU 25	RO072	Romania	Brasov	Fagaras	Nitramonia	1326		Ammonia	Captive
472	EU 25	RO011	Romania	Bacau	Bacau	Sofert	1326		Ammonia	Captive
473	EU 25		Romania			Turnu Magurele	2651		Ammonia	Captive
474	EU 25	DE422	Germany - Deutschland	Cottbus, Kreisfreie Stadt	Schwarze Pumpe	Lautsitzer Analytik	460		Methanol	Captive
475	EU 25	DEA32	Germany - Deutschland	Gelsenkirchen, Kreisfreie Stadt	Gelsenkirchen	Ruhr Oel	997		Methanol	Captive
476	EU 25	DEA27	Germany - Deutschland	Erfkreis	Wesseling	Shell & DEA Mineraloel	1726		Methanol	Captive
477	EU 25	NL112	Netherlands - Nederland	Delfzijl en omgeving	Delfzijl	Methanor	3400	SMR	Methanol; parts sold to FMC Industrial Chemicals (Netherlands) BV for hydrogen peroxide production; Linde is constructing a reformer in Delfzijl to replace H <sub>2</sub> currently produced by Methanor for FMC	Captive
478	EU 25	DEA12	Germany - Deutschland	Duisburg	Duisburg (Schwelgern)	Uhde	3300	COG		By-Product
479	EU 25	DEA12	Germany - Deutschland	Duisburg	Duisburg (Huckingen)	HKM	1375	COG		By-Product
480	EU 25	DE912	Germany - Deutschland	Salzgitter, Kreisfreie Stadt	Salzgitter	Salzgitter Flachstahl	1875	COG		By-Product
481	EU 25	DEB2	Germany - Deutschland	n/a	Dilligen	Zentralkokerei Saar	1625	COG		By-Product
482	EU 25	DEA31	Germany - Deutschland	Bottrop, Kreisfreie Stadt	Bottrop	Prosper	2500	COG		By-Product



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483	EU 25	UKE13	United Kingdom	North and North East Lincolnshire	Scunthorpe	Corus	1663	COG		By-Product
484	EU 25	AT312	Austria - Österreich	Linz-Wels	Linz	VAI Siemens	1763	COG		By-Product
485	EU 25	BE332	Belgium - Belgique - België	Arr. Liège	Seraing	Arcelor	1025	COG		By-Product
486	EU 25	BE234	Belgium - Belgique - België	Arr. Gent	Zelzate	Sidmar	1625	COG		By-Product
487	EU 25		Finland - Suomi		Raahensaio	Ruuki	762.5	COG		By-Product
488	EU 25	FR824	France	Bouches du Rhône	Fos sur Mer	Sollac	1875	COG		By-Product
489	EU 25	ITE16	Italy - Italia	Livorno	Piombino	Lucchini	774	COG		By-Product
490	EU 25	ITD35	Italy - Italia	Venezia	Porto Marghera	Italiana Coke	315	COG		By-Product
491	EU 25	ITC32	Italy - Italia	Savona	San Giuseppe di Cairo	Italiana Coke	674	COG		By-Product
492	EU 25	NL324	Netherlands - Nederland	Agglomeratie Haarlem	IJmuiden	Corus	2663	COG		By-Product
493	EU 25	ES120	Spain - España	Asturias	Aviles	Aceralia	1598.75	COG		By-Product
494	EU 25	ES120	Spain - España	Asturias	Gijon	Aceralia	1250	COG		By-Product
495	EU 25	SE082	Sweden - Sverige	Norrbottnens län	Lulea	SSAB	863	COG		By-Product
496	EU 25	SE010	Sweden - Sverige	Stockholms län	Oxelosund	SSAB	538	COG		By-Product
497	EU 25	UKE13	United Kingdom	North and North East Lincolnshire	Scunthorpe	Corus	1662.5	COG		By-Product
498	EU 25	UKC12	United Kingdom	South Teesside	Teesside	Corus	2500	COG		By-Product
499	EU 25	UKL17	United Kingdom	Bridgend and Neath Port Talbot	PortTalbot	Corus	1825	COG		By-Product