

# **Sustainable Development: Scenarios and Strategies for meeting the world's energy demand with Hydrogen**

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## Contents:

- Still on Probation or Ready for Take-Off?
- Not Technical Possibilities but Consumer Demand
- Evolution of the Aircraft Industry
- Sustainable Development: scenarios for the coming Hydrogen economy
- Worldwide Hydrogen Production Analysis
- Production of Electricity – comparison of Primary Energies vs. Renewable Energies
- Future Hydrogen Production by Renewable Energies
- Regeneration of Electricity – today and tomorrow
- Go to Where the Market is!

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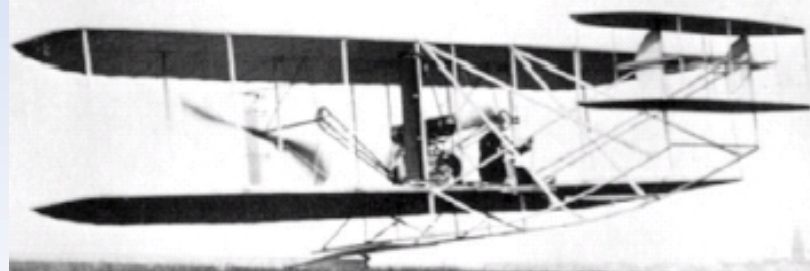
## Still on Probation or Ready for Take-Off ?

- Fuel Cells technology using Hydrogen or another energy carrier has been on worldwide probation for the last 30 years...
- Billions of US \$ – both from Private finance and Government funds - have already been invested
- Adoption was announced several times but often postponed...
- Critical Issues:
  - How long will it take to be commercial?
  - Will H<sub>2</sub>/FC be on probation for another 30 years?

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## > Evolution in the Aircraft Industry 1903 – 2005

### Orville and Wilbur Wright's Flyer



**First powered flight:  
at a beach in Kitty Hawk, N.C.  
December 17, 1903**

*Flight Distance*\_\_\_: 882 ft / 269 m

*Flight Time*\_\_\_\_: 57 seconds

*Passengers*\_\_\_\_: 0

1903

Source: Time Inc. Home Entertainment / Innovation in Our Time

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## > Evolution in the Aircraft Industry 1903 – 2005

### Airbus A380

**In commercial service: 2006**

**– starting with 11 Airlines**

**First flight: April 2005**

*Range* \_\_\_\_\_ : 8.000 nm / 15.000 km

*Wingspan* \_\_\_\_ : 261 ft / 79,5m

*Passengers* \_ : 555



Source: Airbus Industrie, Toulouse, France

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## > Evolution in the Aircraft Industry 1903 – 2005

Orville and Wilbur  
Wright's Flyer

Airbus A380

102 years



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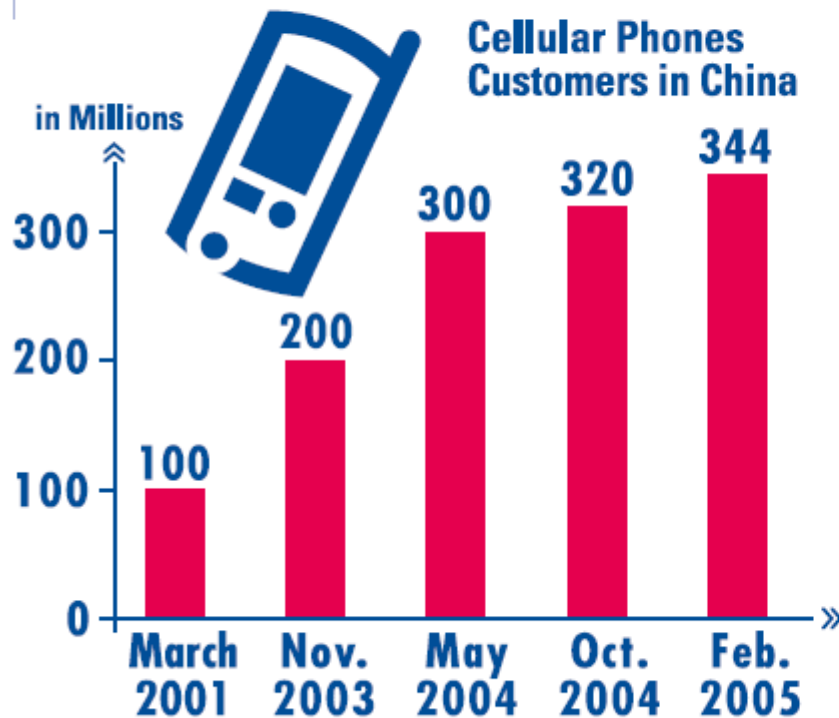
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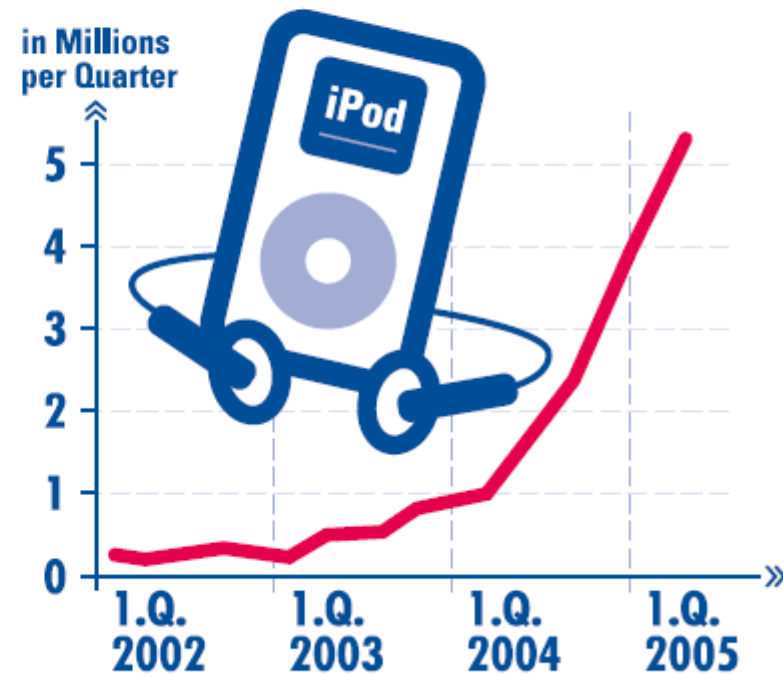
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## > Go to where the Market is:

### Cellular boom in China



### Apple sells 40 iPods per minute worldwide



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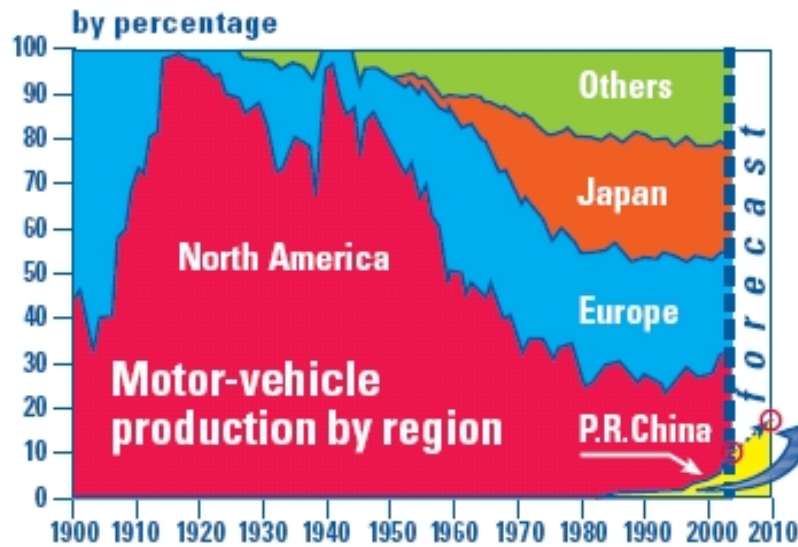
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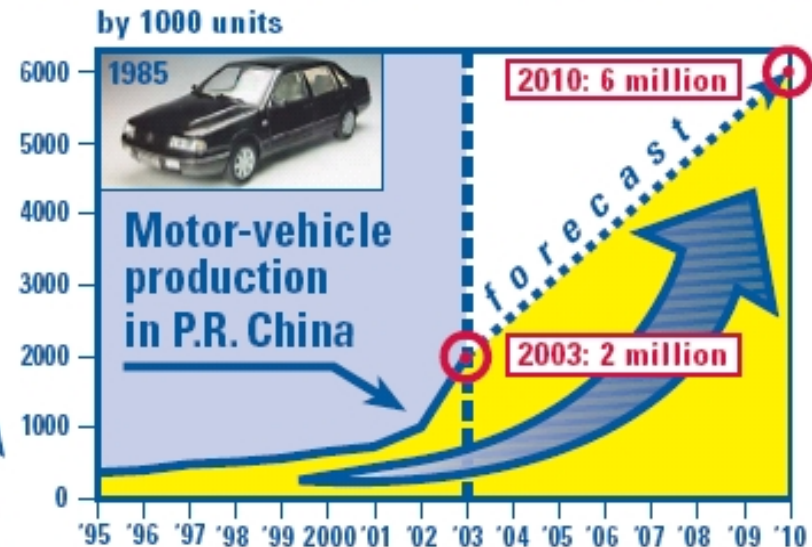


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## > World motor-vehicle production incl. P.R. China 1900 – 2010



Source: Altshuter et al



Source: Prognose-Institut B&D Forecast

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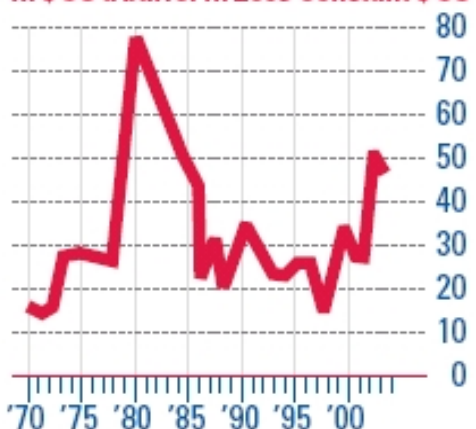


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## > Energy crisis, what energy crisis?

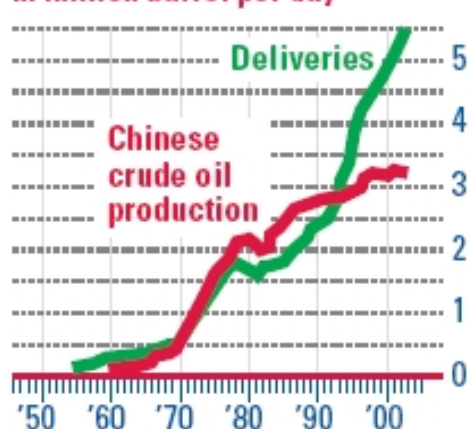
### Crude oil at \$50 US a barrel is really a bargain

Development of crude oil in \$US a barrel in 2003 constant \$US



Source: Canaccord Capital

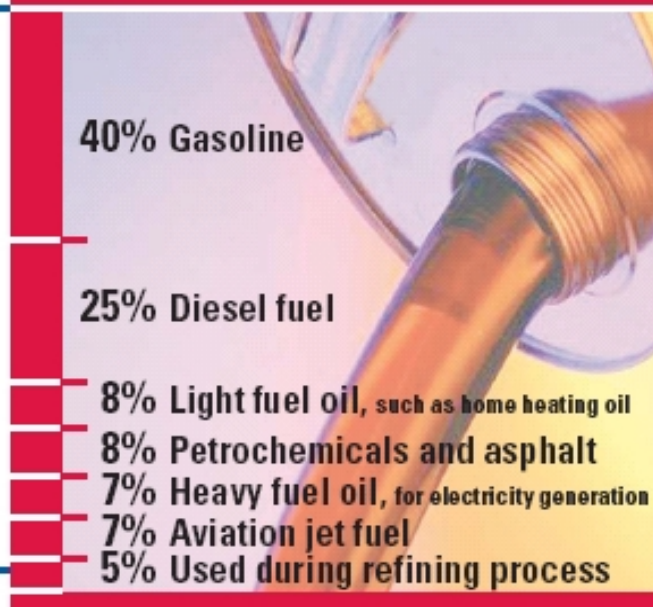
Development of crude oil in China in million barrel per day



Source: The Globe and Mail

China's annual per-capita oil consumption is about 1,5 barrel – roughly the same as in the US 100 years ago.

### Percentage breakdown of products from refining a barrel of crude oil



Source: The Globe and Mail, Sept. 2004

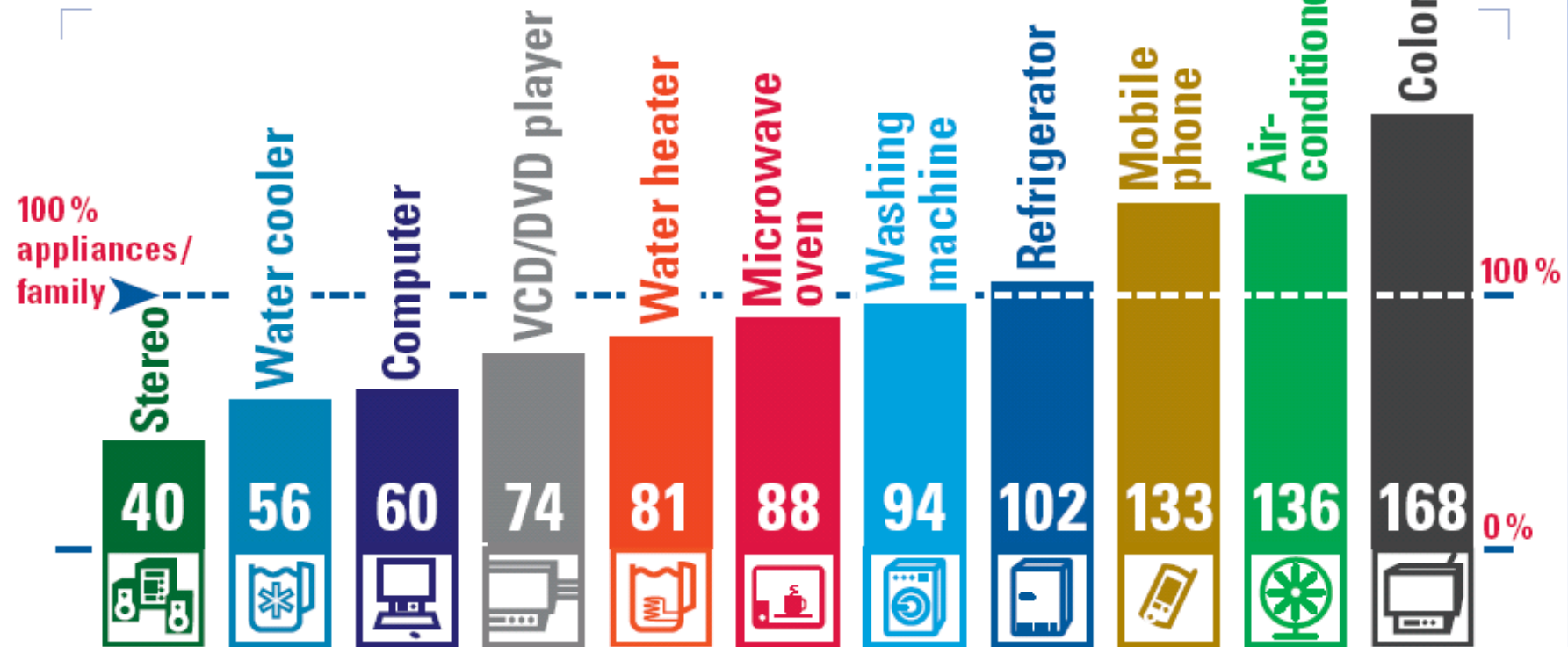
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> Home appliance ownership  
in every 100 Shanghai, P.R. China, families



Source: Shanghai Statistics Bureau, Shanghai Daily, February 6, 2004

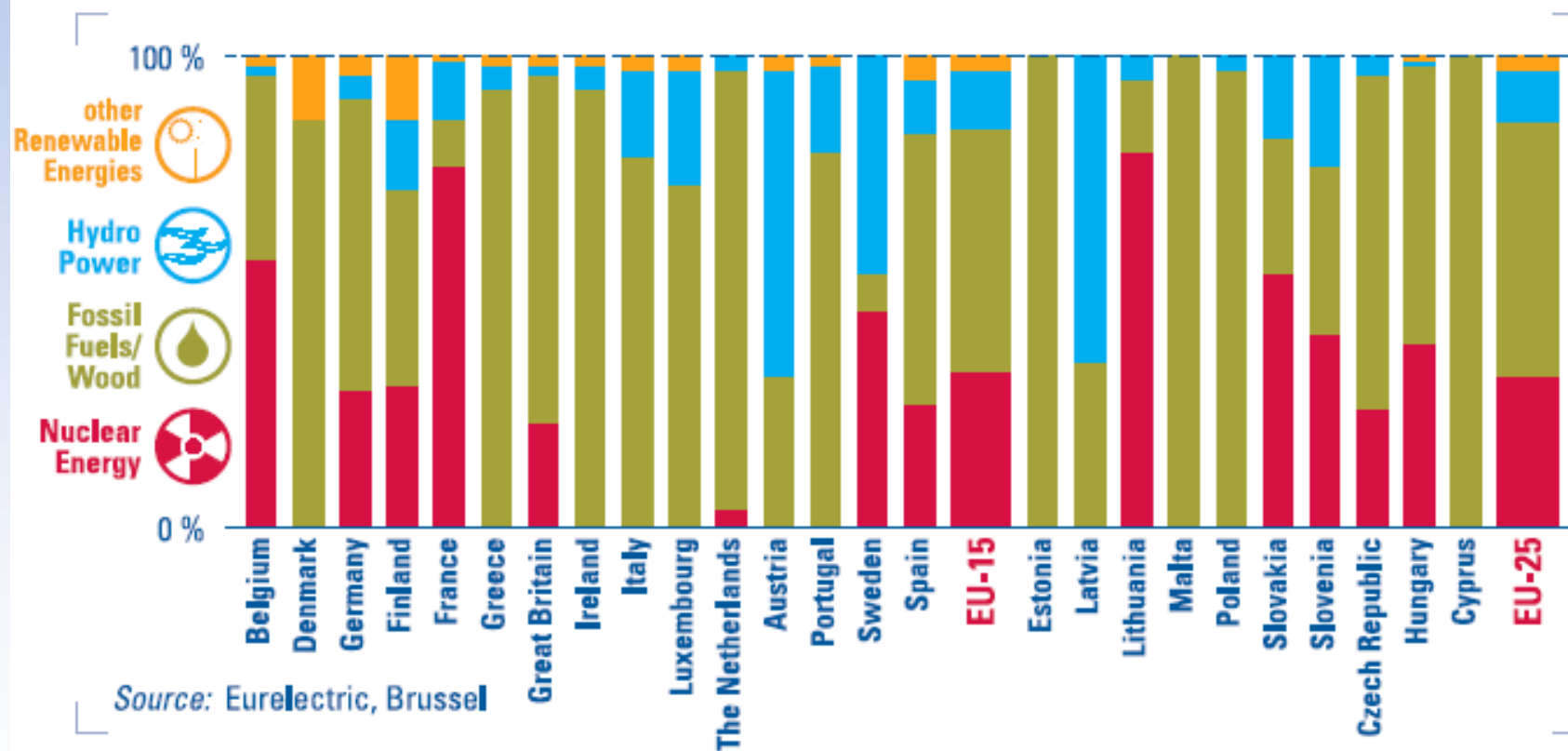
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## Production of Electricity from Primary Energies in 2002 Nuclear Energy, Fossil Fuels, Hydro Power, other Renewable Energies



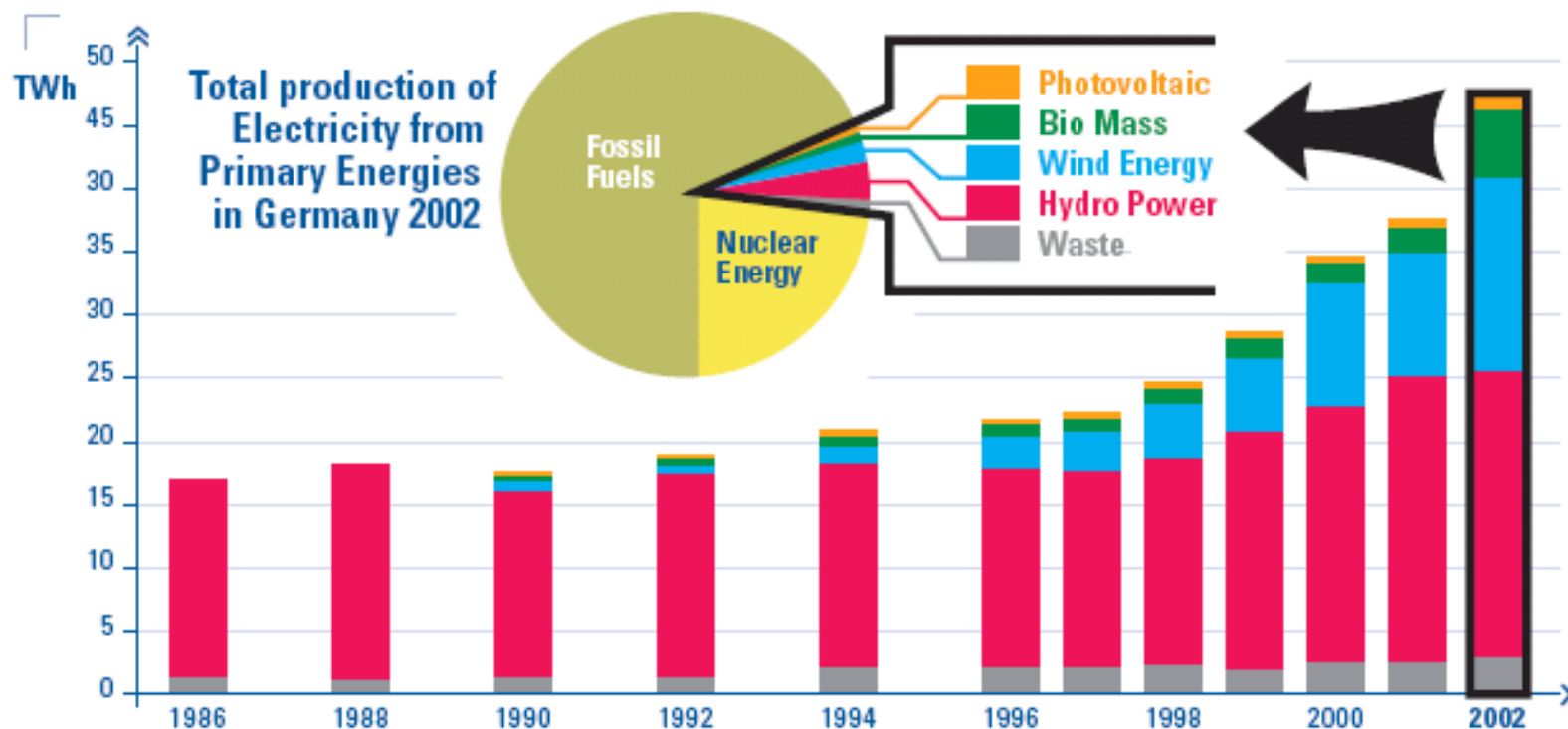
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## > Development of Renewable Energies for Production of Electricity in Germany 1986 – 2002



Source: ew 10, 3. May 2004, das magazin für energiewirtschaft

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Production of Hydrogen – Example 1



Toronto, ON, Canada - Hydrogen refueling station with electrolyser at North America's first urban wind turbine

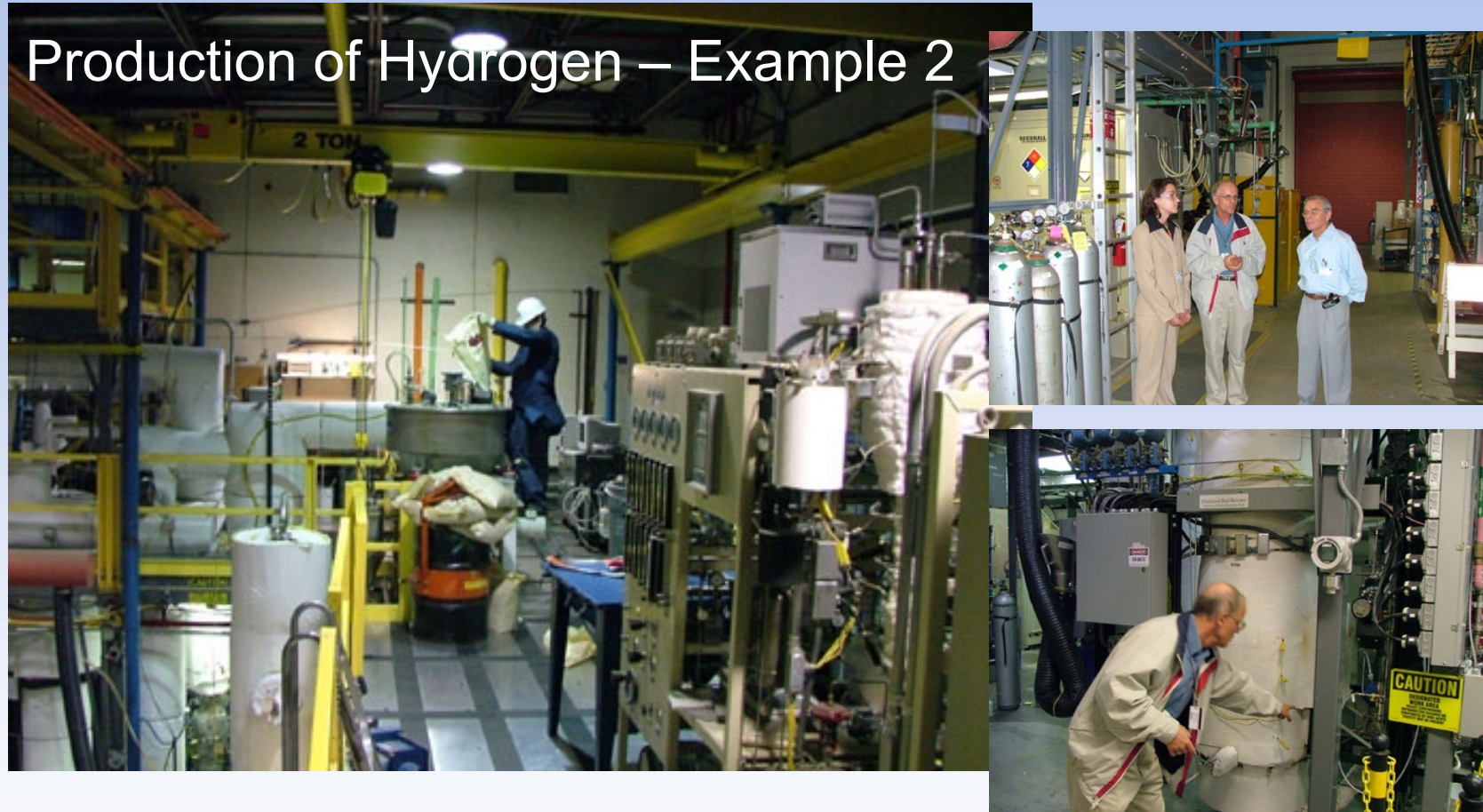
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Production of Hydrogen – Example 2



Golden, CO, USA – Fluidized Bed Reactor for transforming Biomass into Hydrogen as developed & demonstrated at NREL

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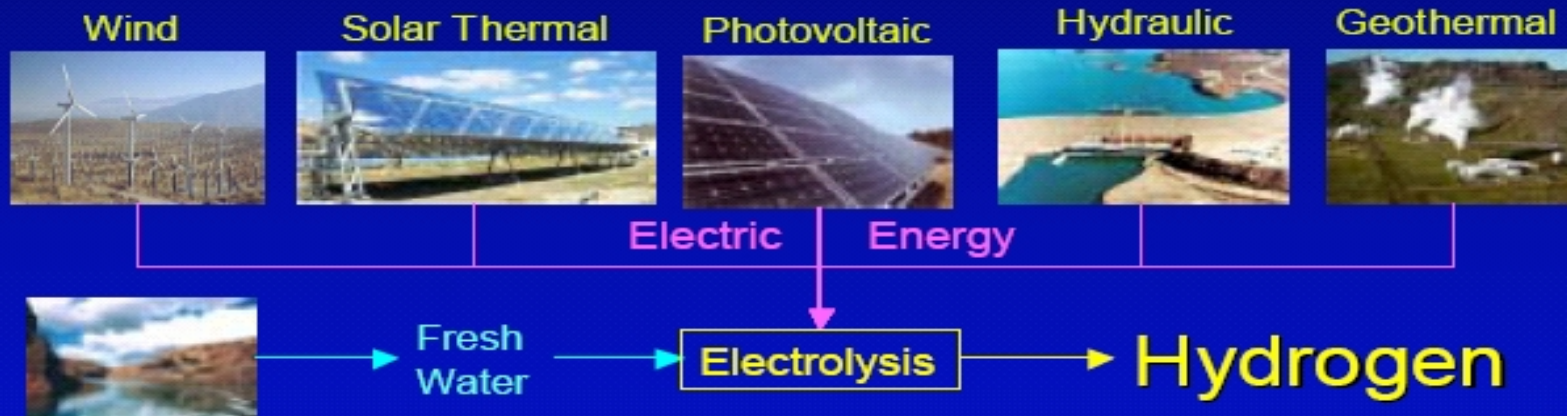
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## Sustainable Development

Develop and Consolidate Energy Production Chains free of GHG Emissions in all phases (Production, Transportation and Consumption) securing Sustainable Development



Renewable Energy Sources must compete with Indirectly Subsidized Fossil Fuels

Source:  C.A.P.S.A –Capex S.A. [www.capex.com.ar](http://www.capex.com.ar)

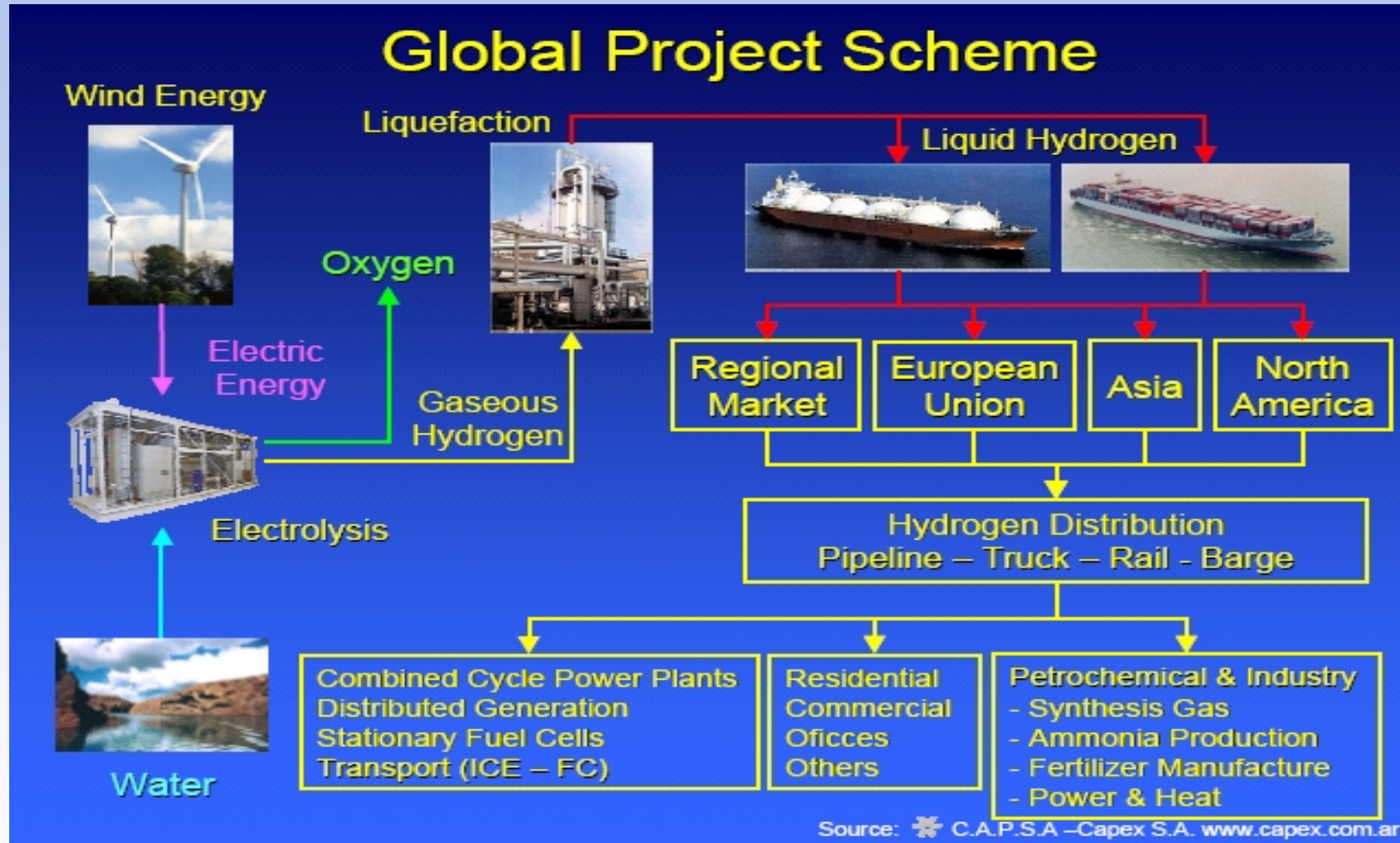
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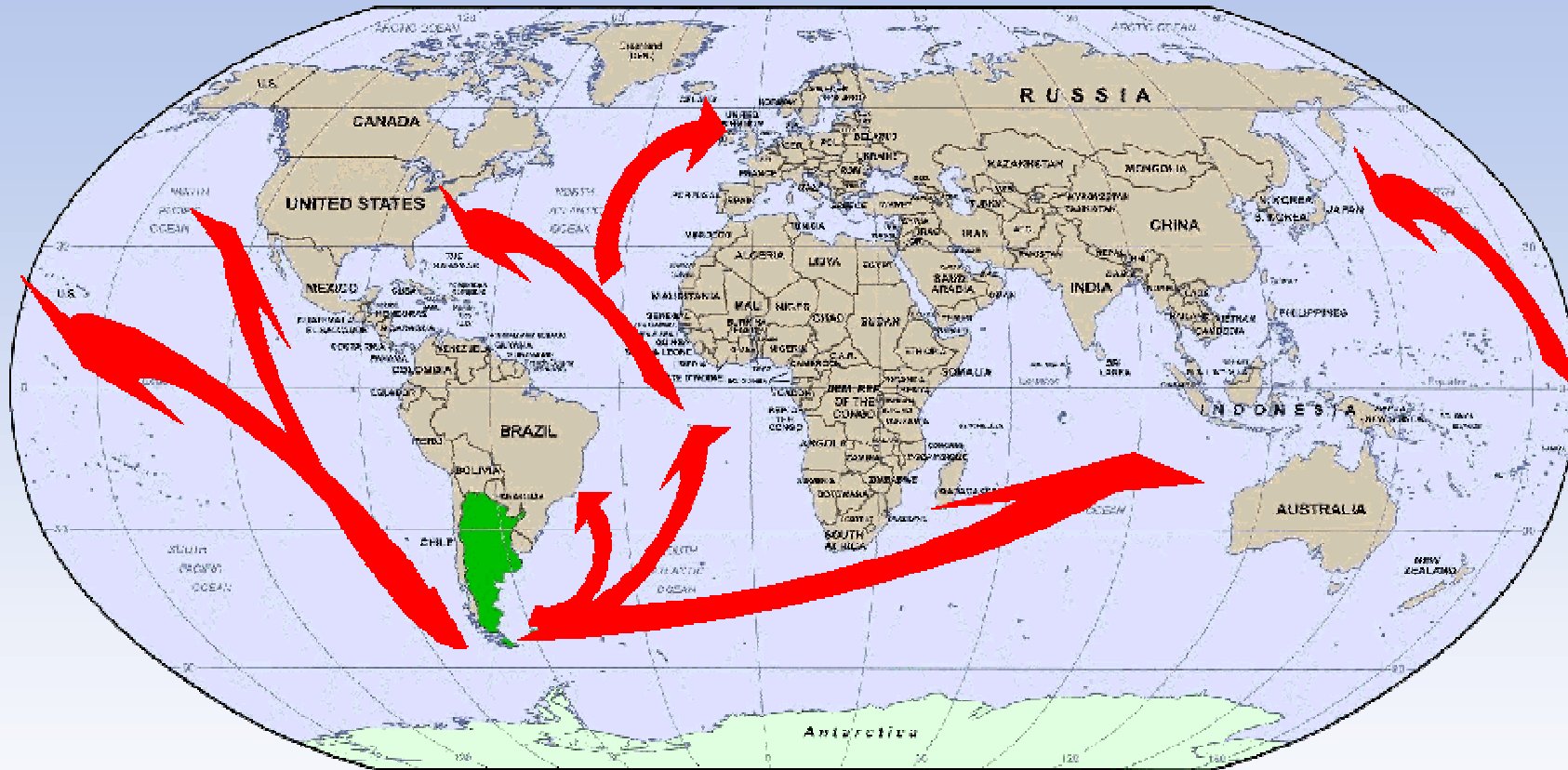


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Flow of Hydrogen from Argentina to supply the world

Source: ✨ C.A.P.S.A –Capex S.A. [www.capex.com.ar](http://www.capex.com.ar)

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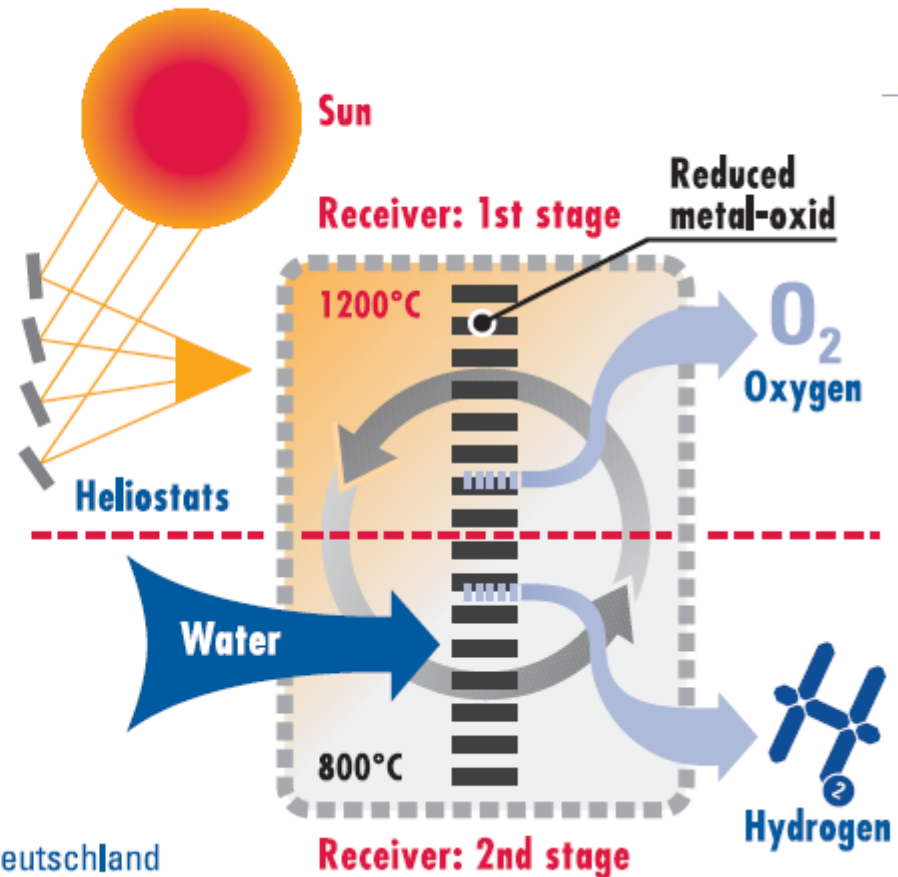


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## > Hydrogen production with Heat from the Sun

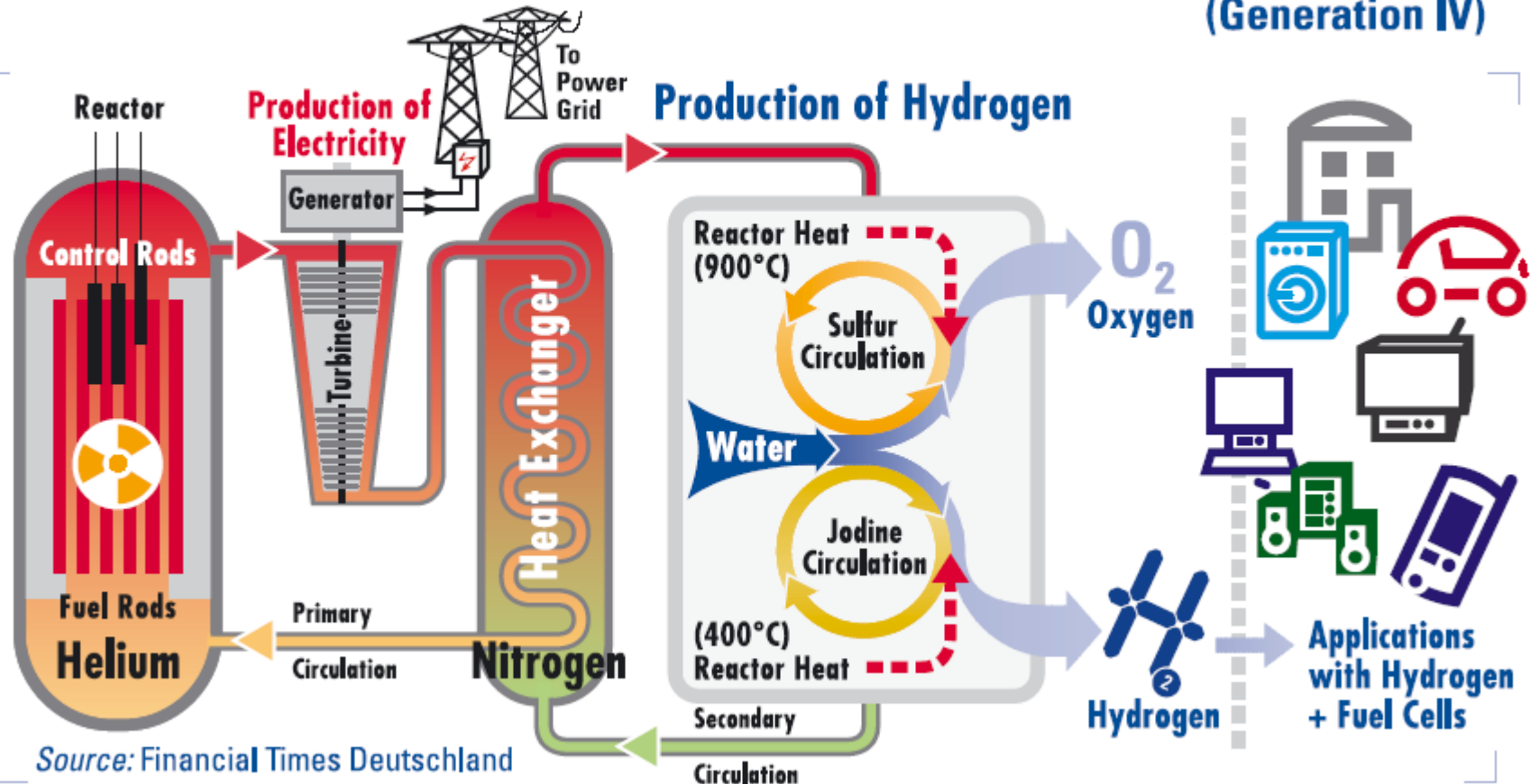


Source: Photos: DLR / Graphic: Financial Times Deutschland



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## > Nuclear Production of Electricity and Hydrogen (Generation IV)



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We invite you to attend our upcoming international Hydrogen and Fuel Cells event...



GROUP  EXHIBIT April 24-28  
Arno A. Evers FAIR-PR  
**Hydrogen  
+ Fuel Cells**  
www.fair-pr.com  
**HANNOVER FAIR '06**  
with INTERNATIONAL CONFERENCE

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## Group Exhibit Hydrogen + Fuel Cells HANNOVER FAIR

- The annual Group Exhibit has developed to be the biggest of its kind in the world since 1995.
- 117 Exhibitors and Forum Participants from 21 countries showed their latest developments in 2005

**Go to [www.fair-pr.com](http://www.fair-pr.com) to check out all the onsite activities, photos and statements**

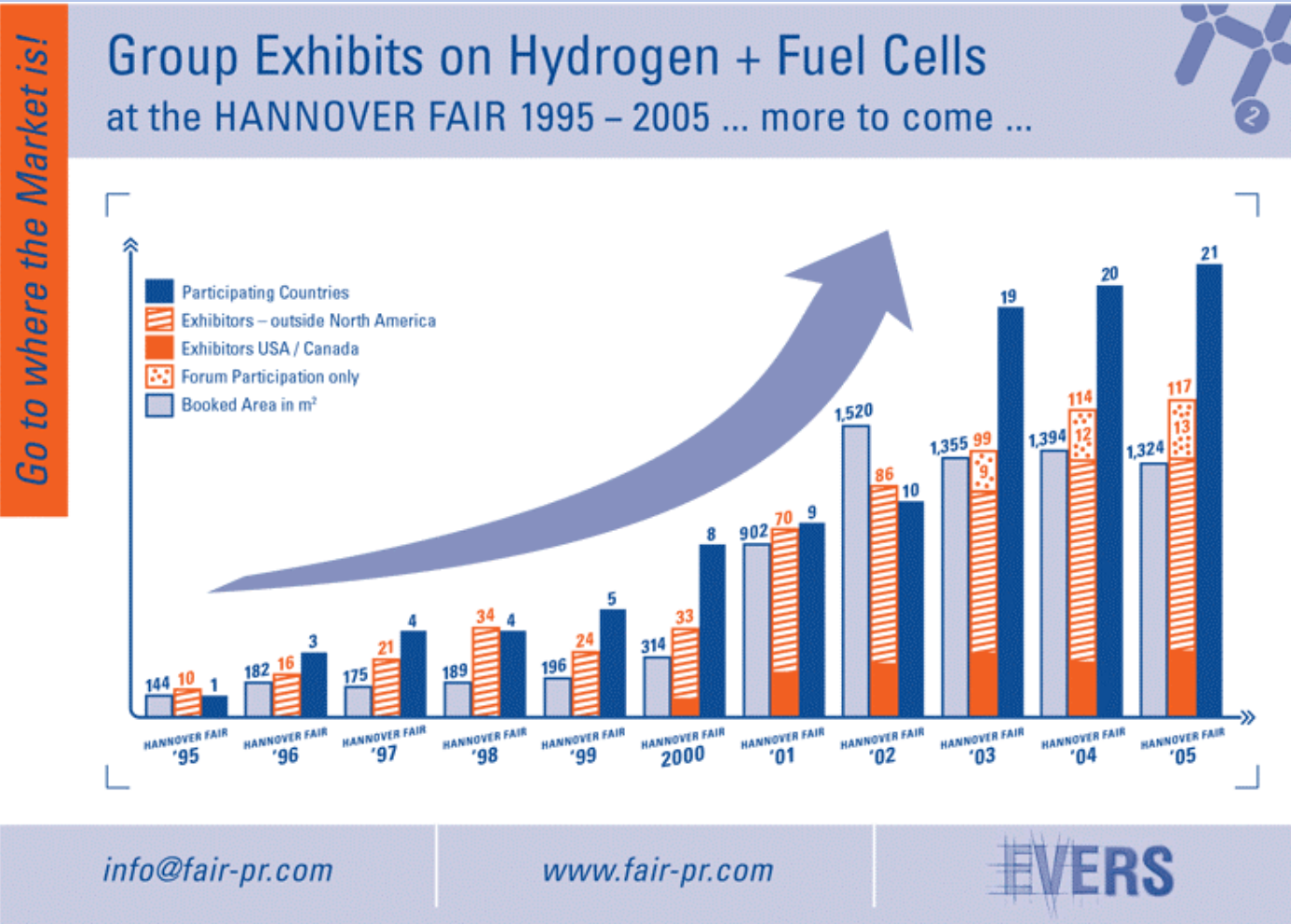
The next HANNOVER FAIR → April 24 - 28, 2006

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**See you in Hannover April 2006!**

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