The Kuwait Energy Initiative

Introduction to the Kuwait Energy Initiative

Developing New Energy market

The global energy solution

- Solar electricity
- Hydrogen for transportation
- Electric grid stabilisation
- The best of all: Immediate results

Those who ignore the signs of the times
will be punished by the economic evolution.

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Energy Market Variations

Good Years: From 1993 until 2000 United States and the global economy experienced eight years of peace and prosperity.

Bad Years: The following years, from 2001 on, destabilised nations, emission of greenhouse gases exploded, and worst of all, a financial crisis of unprecedented severity which is getting worse day by day reduced the investments for climate protection.

Good Years to come: The European Union and big business corporations realised the potentials of sustainable energy and created the DESERTEC Industrial Initiative. The car makers are changing their models. A new view of technology and a new view of aesthetics are demanded. Changes happen overnight. Dynamic and immediate results are driving the international market.

To join this market the philosophy of Kuwait Energy Initiative is built on reasonable investment and immediate revenues.

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Energy Market Variations

Nuclear power plants
Growing public opposition because of recent accidents in French power plants with radioactive spills. German powerplants of Vattenfal are of safety concern.

Experts find no safe disposal of nuclear waste
There is no solution to get rid of nuclear waste. In Germany salt mine repository Asse 2 has become unstable and is closed. Radioactive spill is contaminating groundwater.

USA stores nuclear waste unprotected.

Desert Energy Project

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Energy Market Variations

Oil natural gas and coal reserves are to precious to be burned
Plastics, textiles, drugs lubricants and a broad spectrum of industries depend on oil as raw ware.

Energy reserves are limited
Energy demand of USA, China and India is experiencing an exponential growth. Price of fossil energy will increase as soon production gets difficult.

Climate protection
The governments of industrialised countries realise the necessity to reduce CO2 emission. Climate protection has become top priority national agreements such as the Copenhagen Conference in December 2009.

Emission Trading (Cap and Trade)
There are active trading programs in several pollutants. For greenhouse gases the largest is the European Union Emission Trading Scheme. In the United States there is a national market to reduce acid rain and several regional markets in nitrogen oxides. The US prepare to adopt the European Trading Scheme in December.

The Emission Trading will turn the coal power plant, largely used in Germany, less competitive as a fuel.

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Energy Market Variations

INDIA

National Solar Mission by Prime Minister Manmohan Singh and environminister Jiram Ramesh Ramesh aims to cut reliance on coal investing $ 19 billion in solar energy.

It envisions three phases starting with 1-1.5 GW by 2012 along with steps to drive down production costs of solar panels and spur domestic manufacturing. The world now produces about 14 gigawatts (GW) of solar power, about half of it added last year.

The move could unlock India's huge renewables potential and benefit companies such as Tata BP Solar, a joint venture between Tata Power (TTPW.BO) and BP plc's (BP.L) solar unit, BP Solar, and Bharat Heavy Electricals Ltd (BHEL.BO), a state-run power and engineering equipment firm, and Lanco Infratech (LAIN.BO).

CHINA

Shares in Chinese solar equipment firms like Suntech Power Holdings (STP.N) and Trina Solar (TSL.N) have tripled since March, when Beijing first announced subsidies; Beijing is widely expected soon to raise its solar target to up to 20 GW by 2020.

JAPAN

Japan is targetting 28 GW of solar power by 2020.

http://uk.reuters.com/article/idUKDEL104230._CH_.2420

AUSTRALIA

Australian Prime Minister Kevin Rudd vows to create 50,000 'green' jobs in a two years program in renewable energy.
http://www.google.com/hostednews/ap/article/ALeqM5gzgIh1P7YMP70--KWqGIw6B5JK1AD99OKIVO1

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Energy Market Variations

NORWAY

Norway plans a 580 km hydrogen freeway between Oslo and Stavanger. The Norway Oil Company HyNor acquired 30 Mazda RX-8 Hydrogen RE cars, to run on the freeway in summer 2008.

http://www.greencarcongress.com/2005/05/norway_funds_it.html

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Energy Market Variations

Germany
Focuses on photovoltaic and Wind turbines such as off-shore wind farm.

Germany 1.600 sunshine hour/year

Desert area 3.000 sunshine hours/Year

Germany strongly supports DESERTEC to import electricity from Africa.

Germany depends on coal firing power plants

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Energy Market Variations

The DESERTEC Foundation

DESERTEC Foundation was built on studies carried out by the German Aerospace Center (DLR) on behalf of the German Federal Ministry for the Environment to supply Europe with energy from deserts.

The DESERTEC Industrial Initiative [DII]
400 Billion Euro
Focused exclusively on concentrating solar collectors, steam turbines and heat storage devices. These are real bulk technical sophisticated systems which are not scalable. The planing and construction time is enormous. The durability under desert conditions is limited by abrasion of the mirrors due to sandstorms. The system is invariably bounded to a perfect function of a sun tracking systems which includes moving parts embedded in an hostile environment. Heat storage tanks with temperatures up to 400°C may lead to dangerous leaks and targets to terrorist groups.
The 400 Billion Euro project planed by the DESERTEC INDUSTRIAL INITIATIVE (DII) will discourage small enterprises and developing countries will be unable to invest even fractions of the initial money needed before any outcome is achieved.

[1] DESERTEC Foundation
http://www.desertec.org/en/foundation/

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The 12 founder companies of DESERTEC INDUSTRIAl

ABB
ABENGOA Solar
Cevital
Deutsche Bank
E.ON
HSH Nordbank
MAN Solar Millennium
Munich Re
M+W Zander
RWE
SCHOTT Solar
SIEMENS

The Solar Energy Wealth of the Arab States

Electricity in Europe is mainly produced by nuclear power plants and burning brown coal. Both are seen as extremely unfriendly to nature.

The Arabian deserts have both important qualities needed for the project:

- Sufficient area which does not compete with agriculture or other uses.
- High solar incidence during all seasons.

Solar energy is the greatest wealth of the Islamic world which has not been exploited yet. It is renewable clean energy which is free of pollution and will last forever.

The Energy Portfolio

With the production of electricity and Hydrogen Kuwait opens a new energy market segment.

This may secure their dominance in the future energy economy.
Solar energy does not compete with oil economy because electricity in western countries is mainly won from nuclear power or from brown coal, or wind turbines which are generating about 18 per cent of electricity of the grid in Denmark and are planed to be increased up to 50 per cent.

The Kuwait energy initiative offers a strategy to start business with a low budget. Risks for investors are assessable.

The Kuwait Energy Initiative

Introduction to the Kuwait Energy Initiative

Wind Turbines

Technically very complicated.
Many troubles are known.
Three bladed, upwind, horizontal axis machines, typically larger than 1 MW capacity.

The rotational energy is transferred through a gearbox to a generator, where it is converted into electricity. There are about 19 separate components for the wind turbine.

When the wind blows over 60 mph the mechanism turns 90 degrees from prevailing winds to reduce stress on internal components and to prevent stalling due to over-speed conditions.

Difficult construction
Based on moving parts
No location change possible

Solar-Thermal Plants

- Very long planing and construction time.
- Very sophisticated tracking system and heavy concrete foundations needed.
- Steam turbine as core of the system

Nuclear power is a major rival to solar power -- even in sun-rich North Africa and the Middle East. Sarkozy is signing nuclear power agreements with countries from the United Arab Emirates to Algeria, even as he touts a solar plan. Algeria has said it intends to build a nuclear plant within 10 years.

[1] Giant Mirrors Tap Sun, Subsidies in Europe's Clean Power Bid. Blomberg. 24.09.2008.
http://www.bloomberg.com/apps/news?pid=20601109&sid=aESker8lE5B4&refer=exclusive

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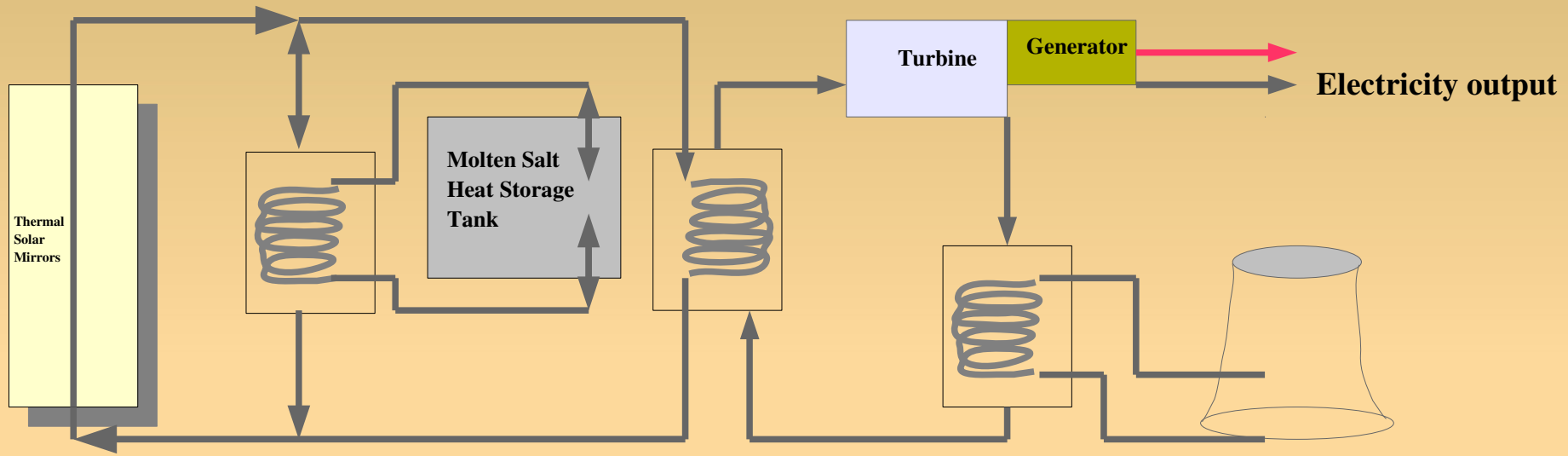
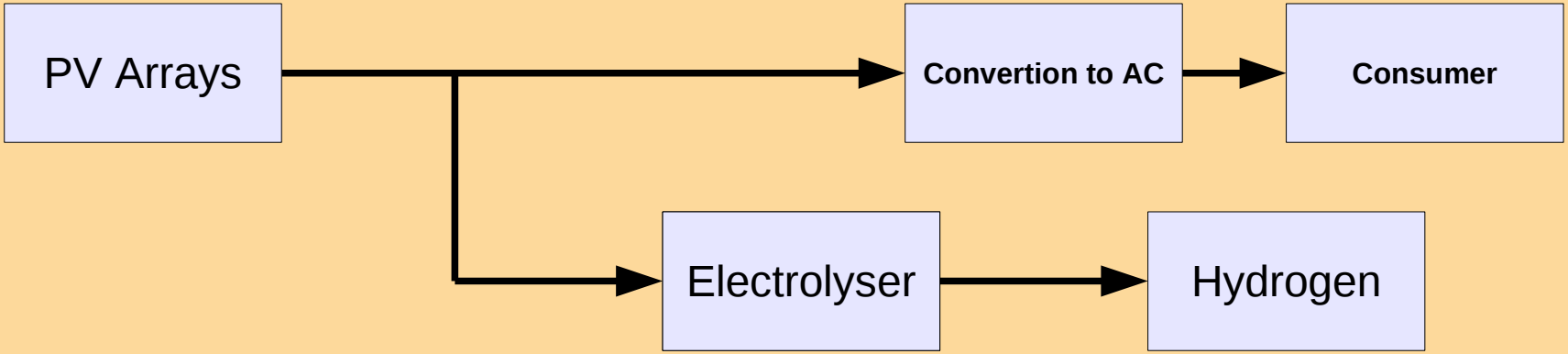


Thermal solar power plant: very complicated system

PV Cells

For dependable, maintenance-free very large photovoltaic array monochystalline silicon cells are recommended. This technology is mature and present best performance under desert conditions.

Install and forget. No maintenance and operational personal needed.
Operation starts with the first installed module.



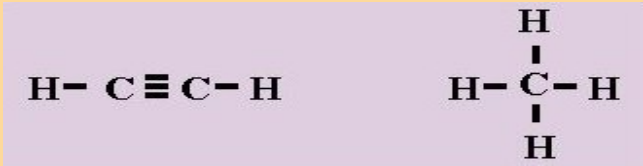
Sustainable Energy
Why change from coal to Solar Energy/Hydrogen?

The Climate Killers: Fossil Energy from Coal, Petrol and Gas
Burning fossil fuel destroys valuable chemical resources the world needs and will rapidly deplete natural stores in a foreseeable time. The climate change due to increasing emission of CO2 by USA, China and India is accelerating the rapid depletion process.

CH3...CH3 + 8O2 = CO2 + 4H2O + C (soot particles) + Sulphur + SO2 + Ash + Energy

Oil and some Gases

High C:H Density.
High CO2 Emission



Some Gases

Low C:H density.
Reduced CO2 Emission,
but no zero emission.

All devices based on burning carbon compounds including bio alcohol and bio Diesel, should not be encouraged any more.
Solar energy/hydrogen: has zero emission and will boost business.

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The Climate Killers Targeted by Emission Trading

	Million Metric Tons of Carbon Equivalent	
Carbon dioxide from fossil fuel combustion	1,547.0	(82%)
Methan	175.8	(9%)
Nitrous oxide	97.5	(5%)
Others	31.7	(2%)
HFCs, PFCs, FS6	31.4	(2%)

- **SO2:** Acidifies the soil and sea. Nature is extremely sensitive to PH variations.

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EU Activities on Climate Change

Proposed by the EU Action Plan on Energy, March 2007, Renewed in December 2008.

No Workable Solution

Energy efficiency: Cutting energy consumption by 20% below levels of 1990, through improvement in the energy efficiency by 2020.

-Renewable energy: Increasing renewable energy from 7% to 20%. Bio Diesel and bioalcohol from Brazil will turn their agriculture in monoculture leaving small peasants without usable land.

-Biofuels: Raising biofuels from 1% to 10 %

- Geological storage of CO2: Promoting carbon capture and geological storage (CCS)2 technology in new fossil-fuel power plants, if possible by 2020.

The Kuwait Energy Initiative

The Premium Solution

The best way to handle financial crisis + Climate

- The Hydrogen Initiative: The Initiative may reduce emission by 90% below levels of 1990 by 2015 in engaged countries, and worldwide by 2025.

- The Initiative: The Initiative may provide 100% renewable Energy worldwide by 2025.

- Carbon dioxide emission: Biofuels are based on carbon dioxide emission. Hydrogen fuel is carbon free.

- The extreme costs of Carbon Capture and Store: The Initiative does not produce CO2.

Desert Energy Project

The Big Five

USA has the highest CO2 emission and energy consume per capita.

Country 2007	% of world CO2 emission	% of World Energy consume	% of World Population Mio
USA	**21%**	**20%**	**4,6%**
China	**18%**	**15%**	**20,5%**
Russia	**5%**	**5%**	**2,2%**
India	**4%**	**5%**	**17,0%**
Germany	**3%**	**3%**	**1,3%**

USA has the highest CO2 emission and energy consume. China has lower emission and energy consume as USA, but a five fold population to live from.

The emission and how to avoid it

	CO2 emission	Suggested remedy
Power plants	25%	PV, ISCC electricity for daytime integrated in a mix of fossil/wind energ
Industry	20%	Integration of solar energy to reduce costs
Cars / transport	13%	Hydrogen – cars
Buildings	10%	Solar energy, windmills and hydroelectic
Forestry	17%	Electricity and fuel from solar energy.
Farming	13%	Use of hydrogen as fuel for tractors and machines
Others	2%	Use of electricity and/or hydrogen as fuel

Air traffic must be reduced to a minimum because emission cannot be influenced decisively.

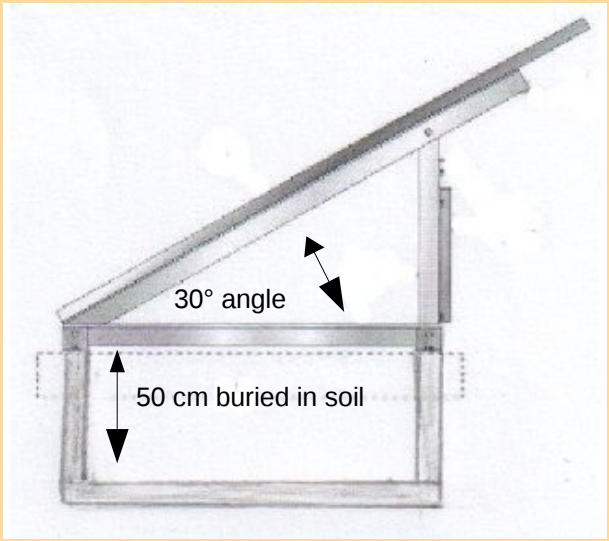
Photovoltaic Modules

Mounting of PV Modules

Modules must be mounted in an angle of 30°. Squared metal construction, buried 50 cm deep provide the support of the PV module mountings. This avoids extensive concrete devices as basis.

No tracking device is used to avoid failure of moving parts, additional fixation volume and high investment. Sun tracking provides an increase of efficiency of 30% but causes failure of the system and requires continuous maintenance of skilled personal. Tracking devices are thus recommended where available area is very limited.

In extensive deserts a maintenance and failure free device without moving parts are essential. Fixed mountings are thus strongly recommended.



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The Kuwait Energy initiative aims to produce solar electricity and hydrogen on demand.

The Start of the System

A good location for a first 100 MW PV array is between Jahrah and Al Salmy.

The first electrolyser may be installed in Kuwait City, or near surroundings.

Direct Current from the PV arrays can be transported anywhere by HVDC line,

When the system evolves to 1 Giga Watt, and up, electrolysers should be located in proximity of a river such as the Nile.

Water consumption: 0,9 litre demin. water is needed for the production of 1 Nm³ Hydrogen.

100 MW system: consumes approximately 21.000 litres water/hour.

1 GW plant: consumes appr. 2 000 Tons of water/d.
Gasoline equivalent: 920 000 litres.
Considering variations of weather conditions equivalence of 500 000 litres may be assumed as average days production of hydrogen.

Desert Energy Project

The Kuwait Energy Initiative

Introduction to the Kuwait Energy Initiative

- **Electrolyzer**

One electrolyser type 485 NM³ may be installed for test production of hydrogen. A total of 450 electrolyzer complete the whole project. All units can be added as needed because of a modular concept which insures perfect customisation and orientation on market demands.

Initial tests may be performed in arid region. Water may be supplied by tank truck. Main production should, however take place in the proximity of a river.

Hydrogen: 100 MWatt/h produces 23.255 Nm³ of Hydrogen/hour equivalent to 9.658 litres gasoline/hour

Hydrogen Transport and filling stations

Hydrogen will be transported in multi-way tanks which can be delivered to gas stations in recycling modus. Bulk transport of these tanks in standard containers which may be mowed on road and on sea. Local production at petrol stations using electricity from the grid may complete the project.

Hydrogen car, how it works

Volkswagen

VW “space up!”

One charge of the lithium-ion batteries brings a range of 100 kilometres. With the hydrogen E-cell drive additional 300 kilometres are available to reach the next hydrogen refill station.

Hydrogen technology is independent of long battery recharging. Battery weighing 180 kg may be substantially reduced , using hydrogen power instead.

The Kuwait Energy Initiative

Introduction to the Kuwait Energy Initiative

http://ecoworld.com/blog/2006/12/20/windmills-vs-photovoltaics/

Desalination

It can already take as little 2.0 kilowatt-hours of electricity, powering a reverse-osmosis system, to desalinate one cubic meter of seawater. If, in a reasonably developed country, the average per capita water usage for all requirements - residential, industrial and agricultural - is about 2,000 meters per year, then at 10.0 cents per kilowatt-hour and 2.0 kilowatt-hours per meter, desalinated seawater would cost $400 per person per year

Europe: Siemens connects the biggest offshore-windpark Great Gabbard situated in the North-Sea 25 kilometres away from the shore of Suffolks. The transmission line will cost 84 Mi EUR. EUR. The whole 500 Megawatt (MW) project was developed by Airtricity and Fluor.

Siemens achieved a turnover of 17 Billion EUR in 2007 connecting energy offshore-windparks with the continental grid and predicts a rise up to 21 Billion Eur for 2011. [2]

[1] Green energy blooms in the desert. guardian.co.uk, Tuesday June 24 2008

http://www.guardian.co.uk/environment/2008/jun/24/energy.energyefficiency

[2] Siemens bindet weltweit größten Offshore-Windpark ans Netz an Erlangen, Deutschland, 13. August 2008

http://www.powergeneration.siemens.de/press/press-releases/power-transmission/2008/EPT200808054.htm

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Payback of Energy Consumed during Production of PV modules [1]

The International Energy Agency (IEA) says that the payback of the energy consumed during the production of the modules will be realized within three to four years, considering the high levels of solar irradiation from deserts.

Emission from production of PV modules can further be reduced to near zero by using the solar energy generated in the earth´s sun belt.

[1] IEA Photovoltaic Power Systems Program: Basics of PV: Environmental Considerations.
http://www.iea-pvps.org/pv/index.htm

Environment [1]

If photovoltaics are located where photosynthesising plants would normally grow, they simply substitute one potentially renewable resource (Biomass) for another.

Solar energy does not compete with plants in desert zones and does not harm environment so as it would do in vegetated regions.

[1] Wikipedia: Photovoltaics
http://en.wikipedia.org/wiki/Photovoltaic

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Hydrogen Source

Currently, hydrogen vehicles utilize hydrogen produced from hydrocarbons by steam reforming. The production of the hydrogen creates additional emissions due to input energy based on fossil fuel and liberates CO2 from the substrate.

Solar energy from photovoltaic farms from the desert turns the production of hydrogen so inexpensive that the introduction will be feasible and emission can be reduced near zero. Hydrogen from electrolysis of water is an energy storage which stabilises the electric grid. Overloads can be diverted to the production on hydrogen for transportation.

Hydrogen Combustion Engine

The common internal combustion engine, usually fuelled with gasoline or diesel liquids, can be converted to run on gaseous hydrogen. Vehicles, using hydrogen and gasoline are ideal for transition time during the implementation of the hydrogen infrastructure. Researches on hydrogen storage built on metal hydrides and compression are progressing.

Electric car is not a global solution

Electric cars equipped with batteries will be of minor importance. Batteries will limit the rage of these cars. The consumer needs a vehicle with unlimited range as he is used to. Hydrogen as clean fuel provides the same advantages of gasoline and can be introduced in standard compression combustion engines with small changes.

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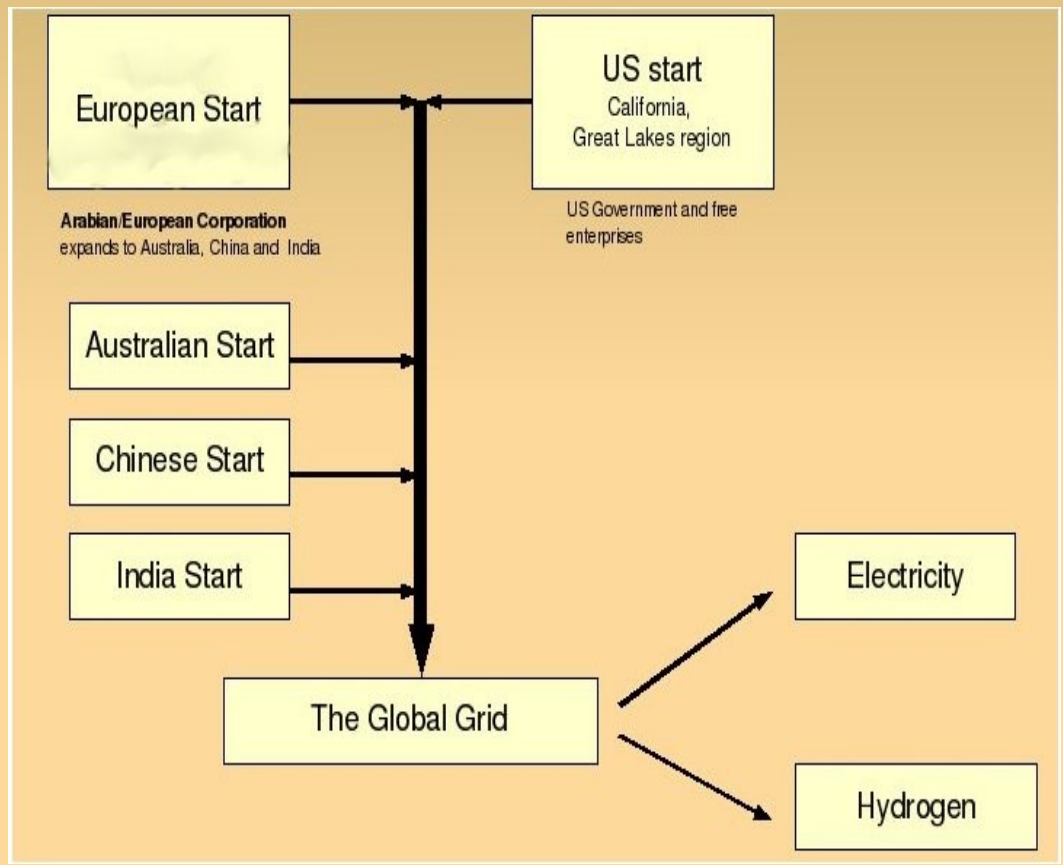
Hydrogen produced by electrolysis of water using solar energy brings global prosperity

Hydrogen Market

Hydrogen as fuel for transportation is a new market niche in Europe. The inexpensive solar electricity from sun belt and the desert can open this market niche for the European and Arabian countries to widen their energy portfolio fit for generations to come.

Hydrogen can reduce the burden of traffic emission in crowded regions. It is where tighter regulations will force the move to a partial replacement of traditional fuel with hydrogen.



Air traffic

The market of jet fuel will remain unaltered strong as there is no alternative for kerosene.

Desert Energy Project

The standard hydrogen engines

Two hydrogen internal combustion engines with twin intake of hydrogen/gasoline should be promoted as standard equipment of European cars:

46kW (63 PS) with 1 litre (1.060 ccm) displacement.

55,2 kW (75 PS) with 1,2 Litre (1.248 ccm) displacement.

Cars equipped with hydrogen engines between 46 kW and 55,2 kW should be free of all taxes. Production made in cooperation between all European car manufacturers will reduce price. There will be no distortion of the market with additional subventions of the European Commission when all car manufacturers can buy the standard engines at the same price.

All car models may retain individual bodywork maintaining a diversified market with two standard engines. All models may also be presented with engines of the conventional engines of the market, regardless to their specifications, but they will keep the present taxes and will not profit of the subventions.

Other long-term vision of sustainable energy systems using of a mix of different variety of energy forms postpone decisions which have to be made today.

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Introduction to the Kuwait Energy Initiative

Summary

Solar energy from the deserts is the gift of nature which may supply energy for whole world. Together with wind turbines and hydro-electric power, integrated in a global grid, clean energy may be available around the globe.
Hydrogen obtained by electrolysing water is the fuel for transportation of the future.

The modular planing of the system allow small local starts to grow easily.. The production of hydrogen can be started on demand. Distribution of hydrogen may be made using recyclable portable tanks being distributed to the petrol stations. Later on hydrogen may be produced at the petrol station with their own equipment, using electricity from the grid.

China is in best position to start solar energy production using Very Large Scale Photovoltaic Power Generation Systems, as described by Kosuke Kurokawa. Detailed feasibility studies were made by the author related to the Gobi Desert.

The desert area West of the city Yinchuan and appropriate location between Yinchuan and Taiyuan is strongly recommended.

U.S.A. Is in a good position to produce solar electricity and hydrogen from its deserts of California and hydro-electric power from the Great Lakes region. Other local starts in Africa, such as the EU Desertec project, and isolated activities in the Middle East, are capable to supply US and Europe with solar electricity and hydrogen. Other important local sites are Australia, India and China, which may be united with a global grid according to Fuller.

The Kuwait Energy Initiative

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Who may Profit from the hydrogen economy?

Car makers: The companies which introduce the hydrogen technology will be leading the world market of cars.

Energy providers: It will be an improvement of their energy portfolio. Investments will be considerably less than drilling for oil.

Improving employment: The whole economy of countries engaged with Solar energy and hydrogen production will have a beneficial impact on job security and wealth from the revenues.

Governments: All governments may profit from a proposal of this global initiative in the decisions of the United Nations Climate Change Conference in Copenhagen in 30. November – 11. December 2009

Who must be on start?

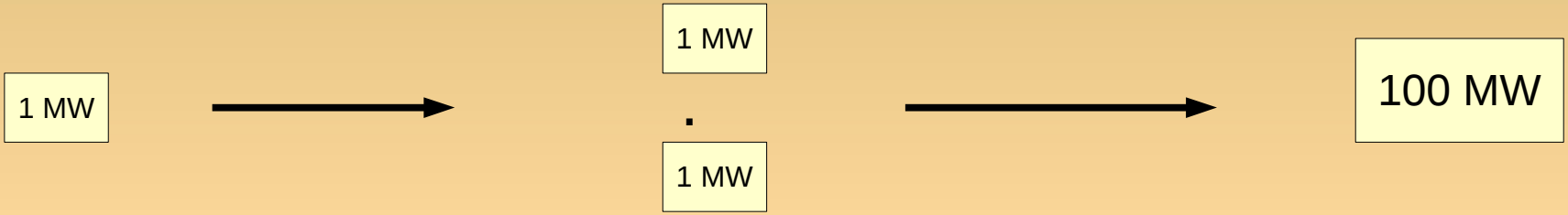
China increases its demand of energy. Solar energy from desert areas and wind turbines may cut the dependence on oil, coal and gas, and even produce an export revenue of electricity and hydrogen as fuel for cars.

Europe, due to its high energy prices, its high population density and its location near to the deserts of Africa is economically and regional structure is predestined for an early start.

U.S.A., the biggest CO2 emitter, relies on cheap coal and low petrol prices. It will be very hard for this country to abandon its politics of war for oil, low energy prices and invest in its energy autonomy.

- **Technical Study**

Modular Buildup



First Unit of 1 MW
4,425,000 EUR

5.556 modules Type 180
130 X 130 Metres area covered

Cost whole construction EUR

Modules	1,900,000
1 Electrolyser	835,000
Planning	240,000
Inverters	400,000
Building	100,000
Construction	950,000
Total	**4,425,000**

More Units of 1 MW added focussed on final 100 MW

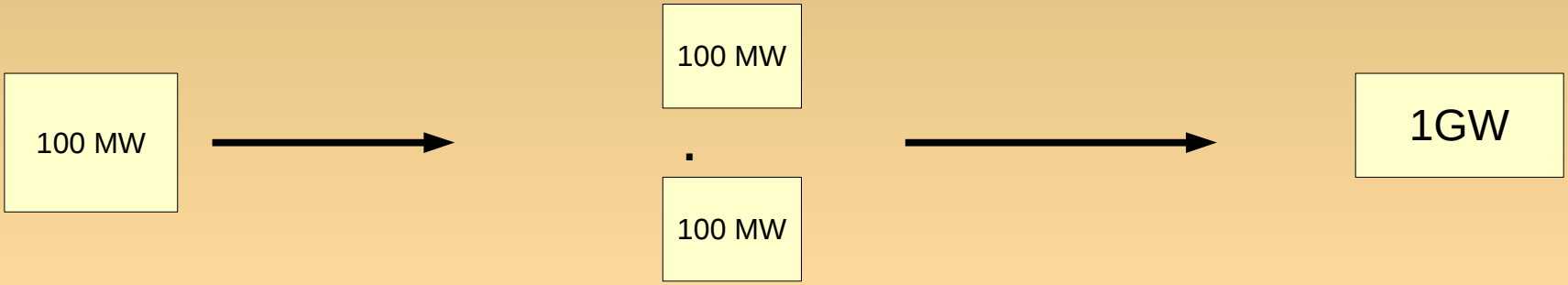
Final 100 MW
343,040,000

555.600 modules Type 180
1,3 X 1,3 Km area covered

Cost whole construction EUR

Modules	190,000,000
45 Electrolysers	30,060,000
Planning	480,000
Inverters	40,000,000
Building	2,500,000
Construction	80,000,000
Total	**343,040,000**

Modular Buildup



First Unit of 100 MW
343,040,000 EUR

→

More Units of 100 MW added focussed on final 1 GW

→

Final 1 GigaW
3,375,080,000 EUR

555.600 modules Type 180
1,3 X 1,3 Km area covered

Cost whole construction EUR

Modules	1,900,000,000
450 Electrolysers	300,600,000
Transmission	550,000,000
Planning	480,000
Inverters	49,000,000
Building	25,000,000
Construction	550,000,000
Total	**3,375,080,000 EUR**

The Kuwait Energy Initiative
Technical Study

100 MW Photovoltaic System

Phase 1 of the project consists of the construction of a 100 MW photovoltaic power plant.
800.000 PV modules with 125 W/h capacity will be linked in 4 units, each consisting of 200 subunits which consist of 4000 PV cells.

The area needed is 2.4 km² (2.1 X 1.1 km). The Number of modules may vary according to the type being used.

Evolving to 1 GigaWatt System

Phase 2, 3 and 4: To complete 1 GigaWatt System nine 100 MW blocks will be added. Transmission cable to Europe from Phase 1 may be used for the initial HVDC line.

Integration of existent solar power plants and Wind turbines

Energy from already existent solar power plants added by wind turbines like off-shore installation may be used for the initial production of hydrogen. The actual energy capacity produced by these plants are, however by far to low for the hydrogen project. Increasing the sites at the Gobi Desert are immediately needed. The Middle East must also be involved as hydrogen demand increases.

This will become a financial incentive to invest in construction, hydrogen infrastructure and car producing industry.

Electrolyzer

One electrolyser type 485 NM³ may be installed for test production of hydrogen. A total of 450 electrolyzer complete the whole project. All units can be added as needed because of a modular concept which insures perfect customisation and orientation on market demands.

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VW “space up!”

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Hydrogen technology is independent of long battery recharging. Battery weighing 180 kg may be substantially reduced , using hydrogen power instead.

BMW

BMW relies on combustion engine which uses hydrogen and switches to petrol in case no hydrogen filling station is reached. The change from hydrogen to petrol happens automatically. BMW aims to reach a fuel efficiency of one kilogram of hydrogen for 100 kilometres.

Ford

Ford announced that it will equip its C-Max model which an hydrogen-combustion engine, as an intermediate step on the way to the fuel-cell. Ford technology uses three tanks with a total volume of 119 litres. Very high compression of the gas enables the car to drive 200 kilometres with one filling. In Berlin Ford hydrogen cars are using the fuel-cell technology.

The Kuwait Energy Initiative
Technical Study

The Start of the System
A small demonstration hydrogen production unit may use the solar energy or use energy from wind turbines. Using peak loads for the hydrogen production may help to stabilise the grid.

To get better performance and have enough area to expand, the existing start of Desertec and the financial cooperation with Arabian countries must be focused on. Politicians are asked to get in contact with Arabian governments and investors. Arabian countries of the Arabian Peninsula have best position to add hydrogen and electricity to their energy export portfolio.

When the system evolves to 1 Giga Watt, and up, electrolysers should be located in proximity of a river.

Water consumption: 0,9 litre demin. water is needed for the production of 1 Nm^3 Hydrogen.

100 MW system: consumes approximately 21.000 litres water/hour.

1 GW plant: consumes around 2 000 Tons of water/d. Gasoline equivalent: 920 000 litres. Considering variations of weather conditions equivalence of 500 000 litres may be assumed as average days production of hydrogen.

HVDC overhead line

Export of electricity to the European Grid will be achieved using High Voltage Direct Current (HVDC) lines. There will be no DC to AC converter from at the end of the line because Europe handles electricity as DC on its grid. DC is therefore welcome.

The overhead transmission line of 2 500 km will interconnect the different blocs and transmit high direct current to the grid.

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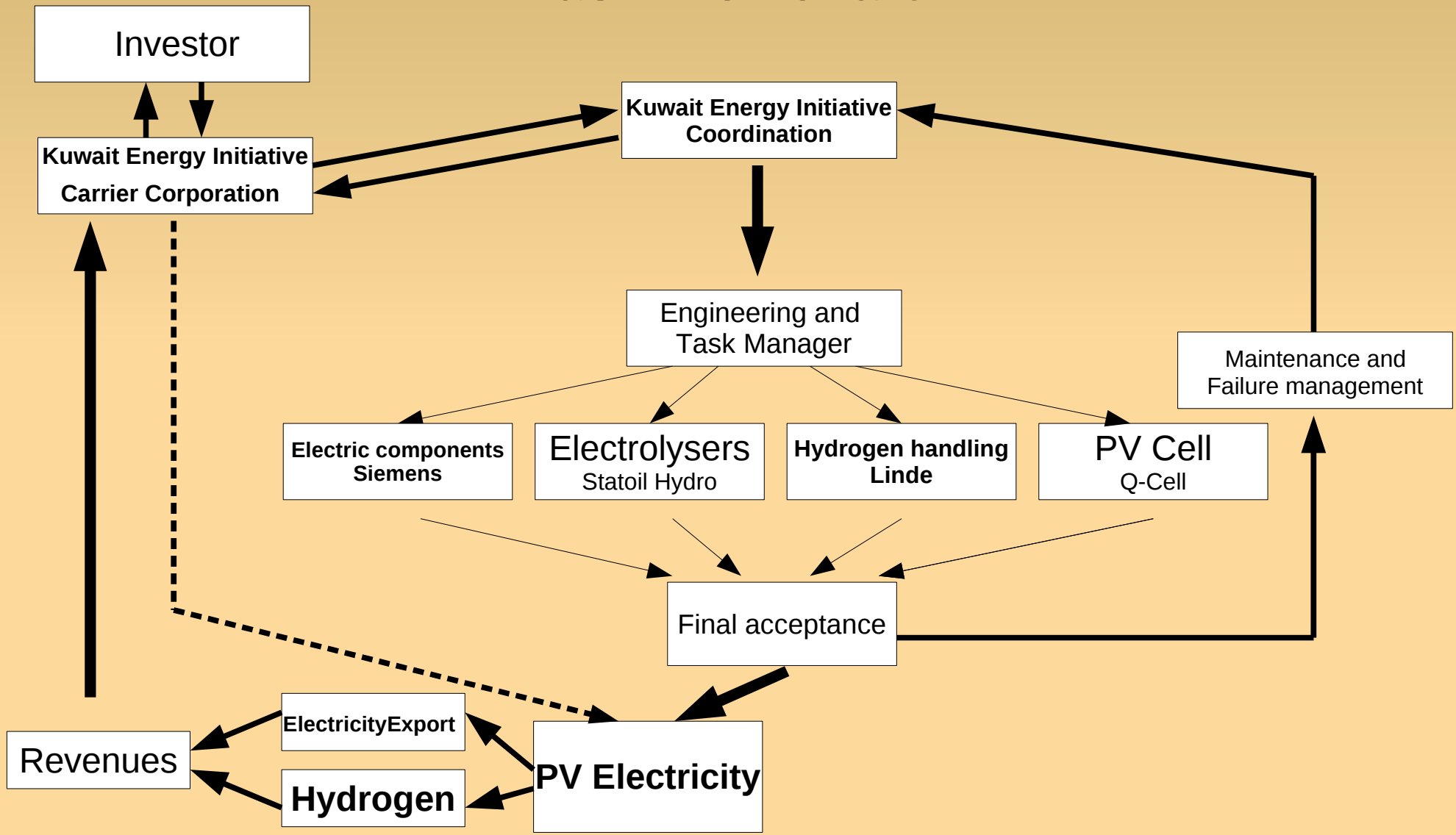
Technical Study

Task Flowchart



Conversion Factors

1Nm³H2= 4,30 KWh
1 kWh = 0,233Nm³H2
1kWh = 0.349 Gallon gasoline
1 Nm³ hydrogen = 0.34 litre gasoline
1 US Gallon = 3.785 litre
1 US Gallon Kerosene = 3.092 Kg
Density of Kerosene= 0.817
Density of gasoline vehicle = 0.737
Density H2 = 0.0899 Kg/Nm³
1 kWh = 0.092 litre gasoline
1 Litre H2 liquid = 0.27 litre gasoline
1 Kg H2 = 2.75 Kg gasoline
0,9 litre water = 1 Nm³ hydrogen
1 EUR = 1.23 US Dollar
10 hours sunshine/day 300 days/Year

Hydrogen Data: http://www.h2data.de/

All monetary conversions are subjected to changes

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- **FINANCING**

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Financing

Prosperous clean energy investment means:

- **Investing in the right tool for the right business**
- **Investing at the right location**
- **Investing in a field not already dominated by established corporations**

Source: New Energy Finance: Global Clean Energy. Investment Overview. Trends and Issues in the Financing of Renewable. Energy and Low-Carbon Technology. Prepared for the Clinton Global Initiative. New York, 20-22 September 2006. http://www.clintonglobalinitiative.org/NETCOMMUNITY/Document.Doc?&id=42

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Financing

- Four financing modalities

Four system dimensions are suggested.
Each one is calculate isolated, not modular.
One Giga Watt/h system modular build is shown under IV.

System	Capacity	Planing expertises	PV Modules 1.90 EUR/W cost	Construction and supplements	Building	Inverters	Electrolysers Units	Electrolysers	DC Cable HVDC EU grid	Cost Sum EUR
I	1 MW	240,000	1,900,000	950,000	100,000	400,000	1	835,000		4,425,000
II	10 MW	240,000	19,000,000	9,500,000	250,000	4,000,000	4	3,340,000		36,330,000
III	100 MW	480,000	190,000,000	80,000,000	2,500,000	40,000,000	45	30,060,000		343,040,000
IV	1 GW	480,000	1,900,000,000	550,000,000	25,000,000	49,000,000	450	300,600,000	550,000,000	3,375,080,000
V	next 1GW	480,000	1,900,000,000	950,000,000	40,000,000		900	751,500,000		3,641,980,000

Yield forecast

System	Capacity	Investment EUR	50% H2 Gasoline Eqiv. Litres/10 hrs day 300 days/year	50% local Electricity use 10 hrs/day 300 days/year	Years to pay Investment Gasl 1,06EUR/l KW 0,10 EUR	Total revenues In 25 years	Carry an interest /year %
I	1 MW	4,425,000	138,000	1,500,000	14,9	2,982,000	3,37
II	10 MW	36,330,000	1,380,000	15,000,000	12,3	37,740,000	5,19
III	100MW	343,040,000	13,800,000	150,000,000	11,6	397,660,000	5,80
IV	1 GW	3,375,080,000	138,000,000	1,500,000,000	11,4	4,031,920,000	5,97
V	1 GW	3,641,980,000	100% H2 276,000,000		12,4	3,672,020,000	5,04

Suggested system I to III:
From 1 to 100MW 50% for H2 and 50% for local use.
No HVDC cable

System IV 1 GW 50% for H2 and export + HVDC cable to EU Grid
System V 1 GW 50% for H2 and export + HVDC cable to EU Grid

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Financing

Suggested Investment Start
1 MW Plant with an Investment of 4,4 Million EUR

The start
- The start with the System of 1 MW which including one electrolyser is being suggested.
The system can be quickly expanded on a modular basis to 100 MW (Investment of 343 Million EUR).

Investment security
-The Photovoltaic start presents the highest level of investment security, because all parts may be easily resold should the holding be dissolved. This is a valuable argument for a no-risk start with PV arrays.

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- **Looking forward**

As the system increases, the investment costs will substantially reduce due to better conditions in material buying.

After consolidation of the initial phase, solar thermal power plants may be integrated in the system. The initial start should, however be made with PV arrays because it is trouble-free, generates immediate outcomes and requires no maintenance.

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Hydrogen as clean fuel

Currently, hydrogen vehicles utilize hydrogen produced from hydrocarbons by steam reforming. The production of the hydrogen creates additional emissions due to input energy based on fossil fuel.

Solar energy from photovoltaic farms from the desert turns the production of hydrogen so inexpensive that the introduction will be feasible and emission can be reduced near zero.

Fuel	g CO2 /km Emission
Petrol	160
Diesel	139
Natural Gas	125
H2 from Gas reforming	250
H2 from Wind/solar energy	25

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Hydrogen engines

The common internal combustion engine, usually fuelled with gasoline (petrol) or diesel liquids, can be converted to run on gaseous hydrogen. However, a more energy efficient use of hydrogen involves the use of fuel cells and electric motors. Researches on hydrogen storage built on metal hydrides and compression are making good progress.

Hydrogen marketing

European efforts for climate protection

Hydrogen as fuel for transportation is a new market niche in the European market. The inexpensive solar electricity from the desert can open this market niche for the Arabian countries to widen their energy portfolio fit for generations to come.

Hydrogen can reduce the burden of traffic emission in crowded regions. It is where tighter regulations will force the move to a partial replacement of traditional fuel with hydrogen.

Air traffic

The market of jet fuel will remain unaltered strong as there is no alternative for kerosene.

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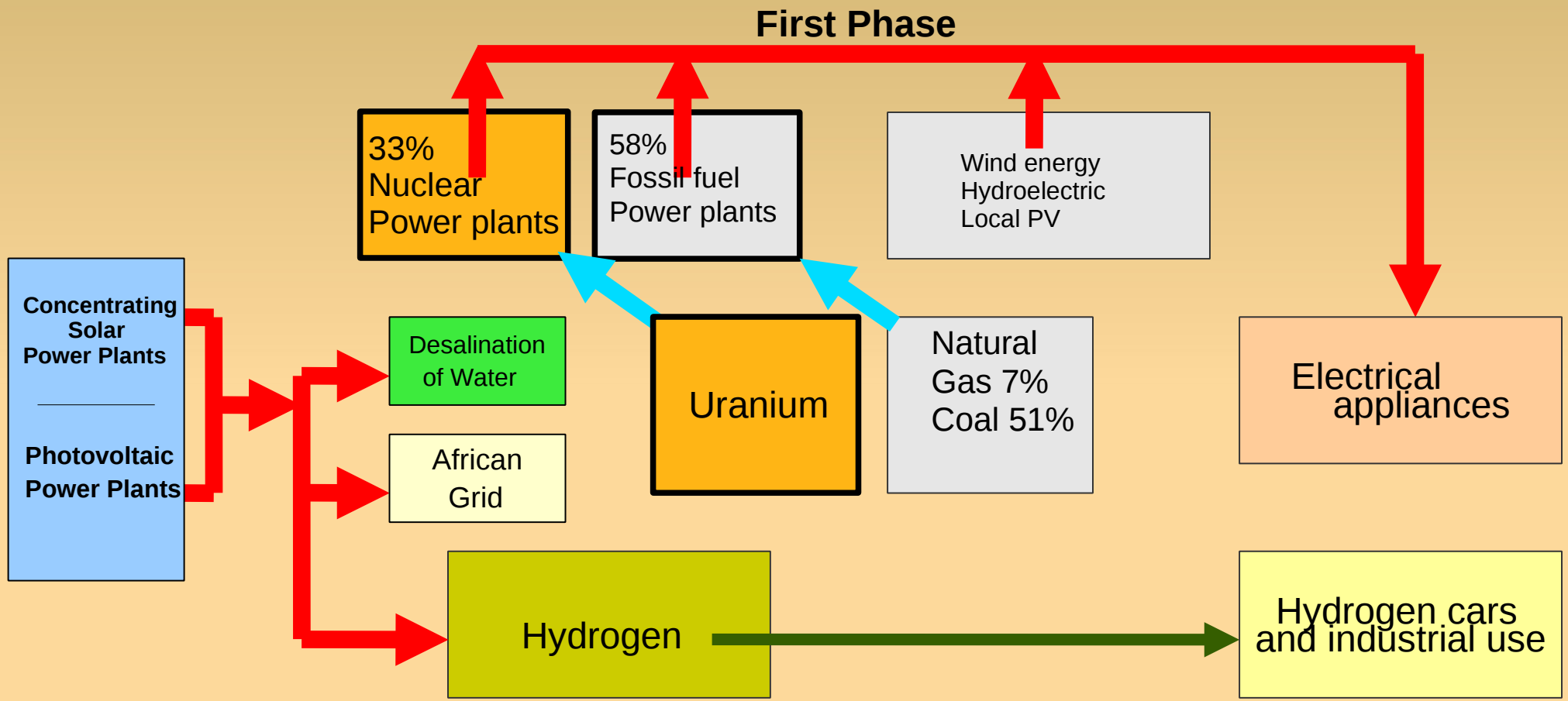

The Initiative may begin in the Australian deserts with the installation of photovoltaic arrays and the production of hydrogen as fuel for cars and a superconducting grid to Europe.

Source: *Science* 1 Nov. 2002. Vol 298. no 5595.pp.981-987
Doi: 10.1126/science.1072357

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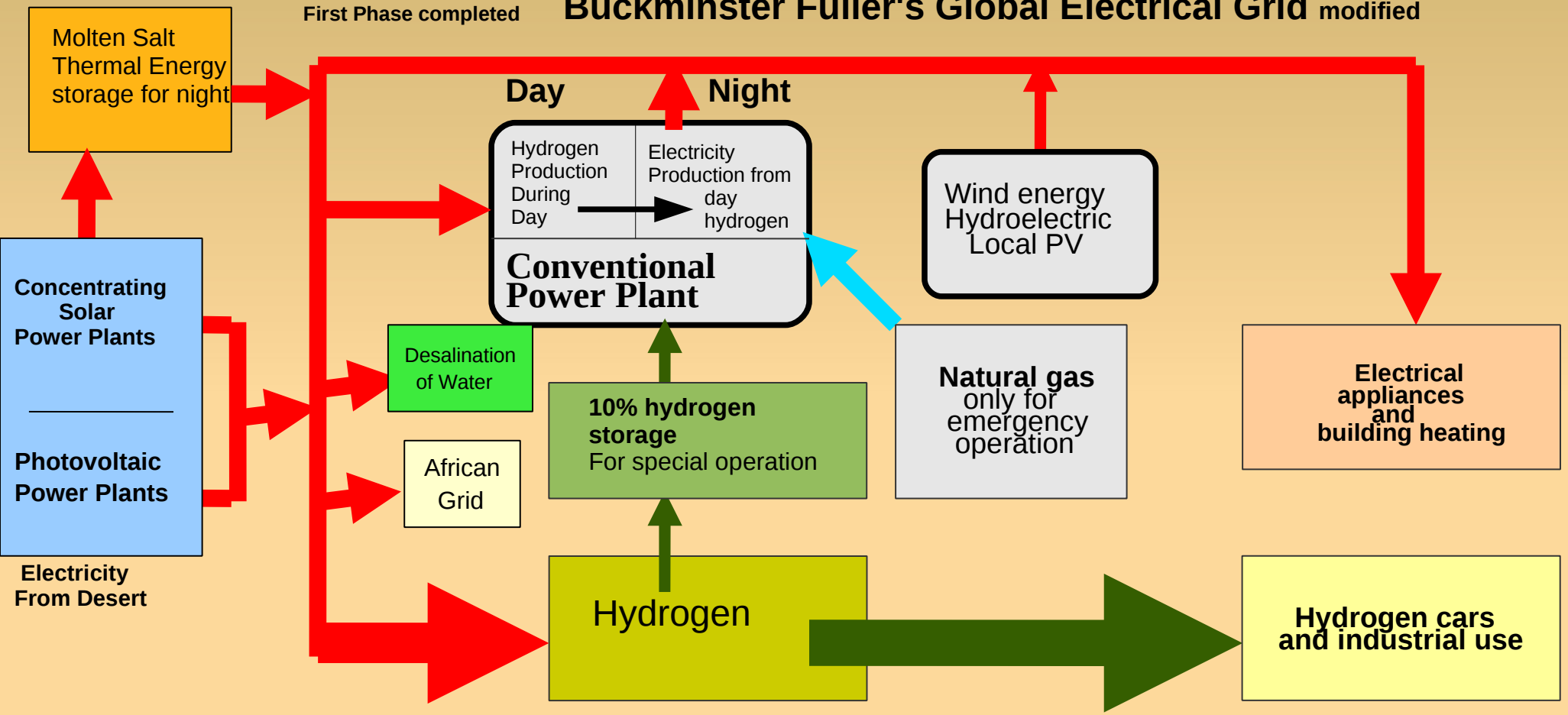

First Phase completed: Electricity from solar energy feeds the European electric grid. During Daytime the power plants store energy by thermal storage and hydrolyses of water. The daytime storage of heat and/or hydrogen can be used to feed the grid during the night.

Source: *Science* 1 Nov. 2002. Vol 298. no 5595.pp.981-987
Doi: 10.1126/science.1072357

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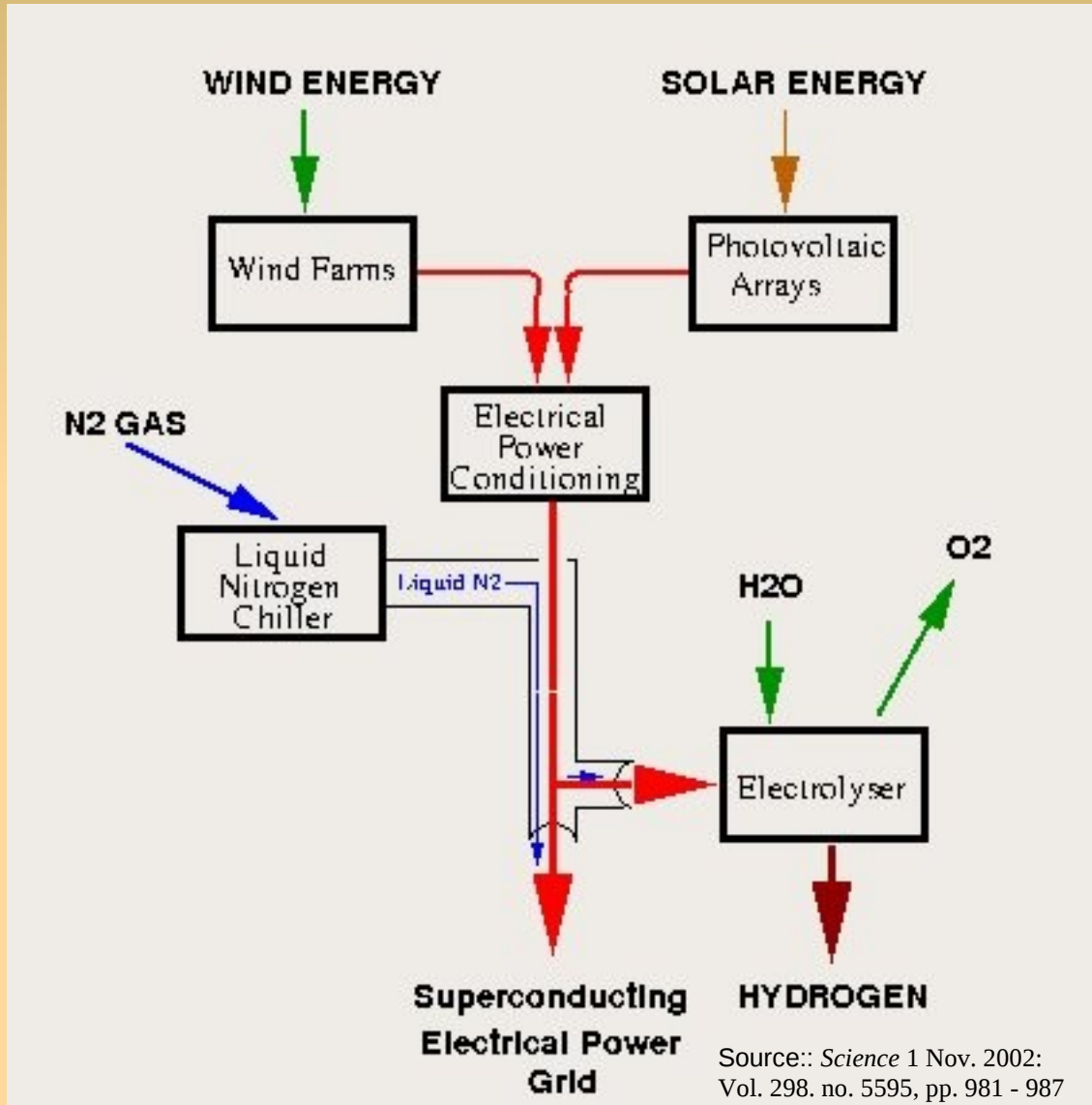
Electricity From The Grid And Hydrogen For Transportation

The Grid:

Wind and Solar Energy is conditioned and fed into the global superconducting electrical Grid for electrical appliances.

Hydrogen:

Part of the electricity is used for the production of hydrogen for Transportation, heating and other applications where the grid does not applies.



Source:: *Science* 1 Nov. 2002: Vol. 298. no. 5595, pp. 981 - 987 DOI: 10.1126/science.1072357

Buckminster Fuller's Global Electrical Grid, modified

Desert Energy Project

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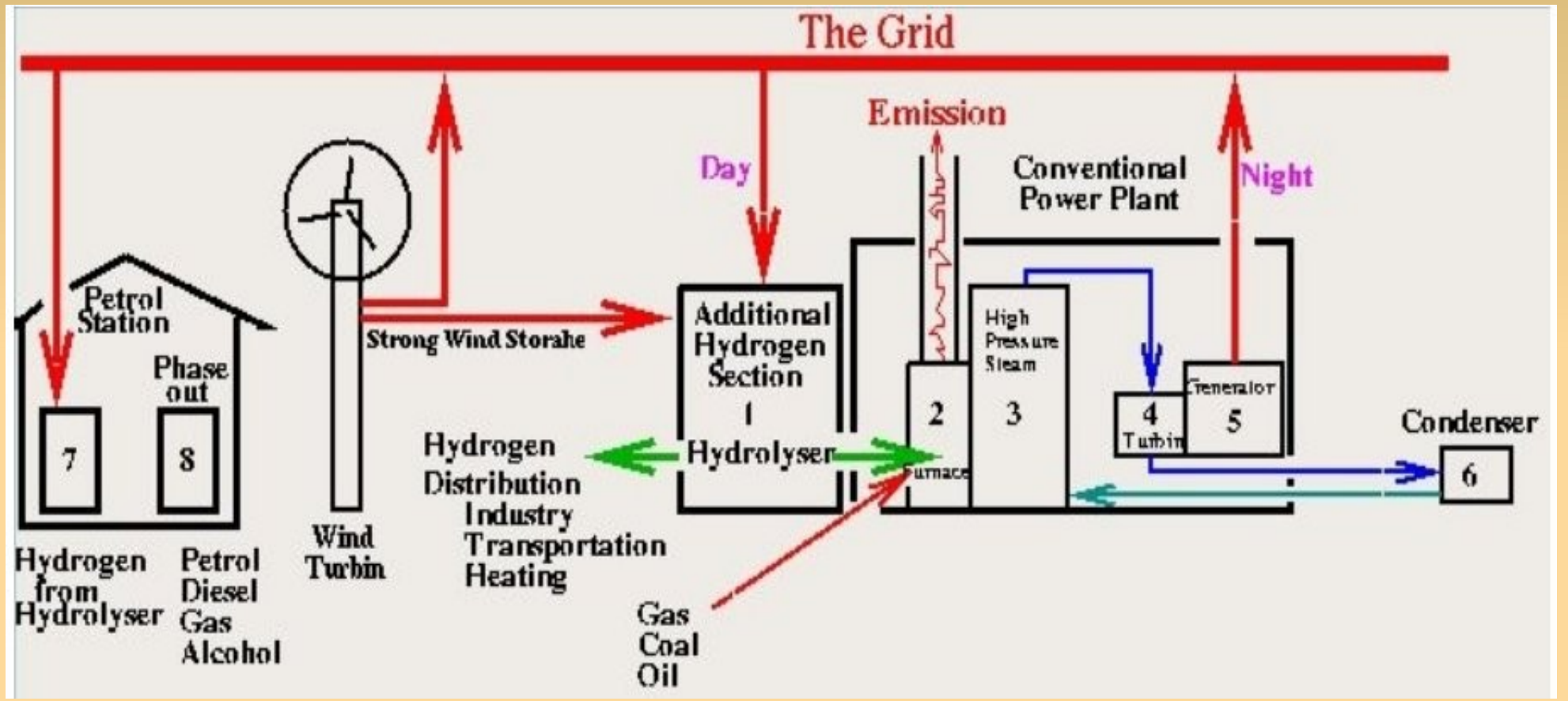
how to put it into action

Storage of wind energy as hydrogen, and use as fuel for transportation



1. Hydrogen Hydrolysis
2. Furnace of Power Plant
3. High Pressure Steam
4. Turbin
5. Generator
6. Condenser
7. Hydrogen Electrolyser at Local Petrol Station
8. Phase-out of Carbon Based Fuel

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The Buckmister Fuller's Global Electrical Grid modified

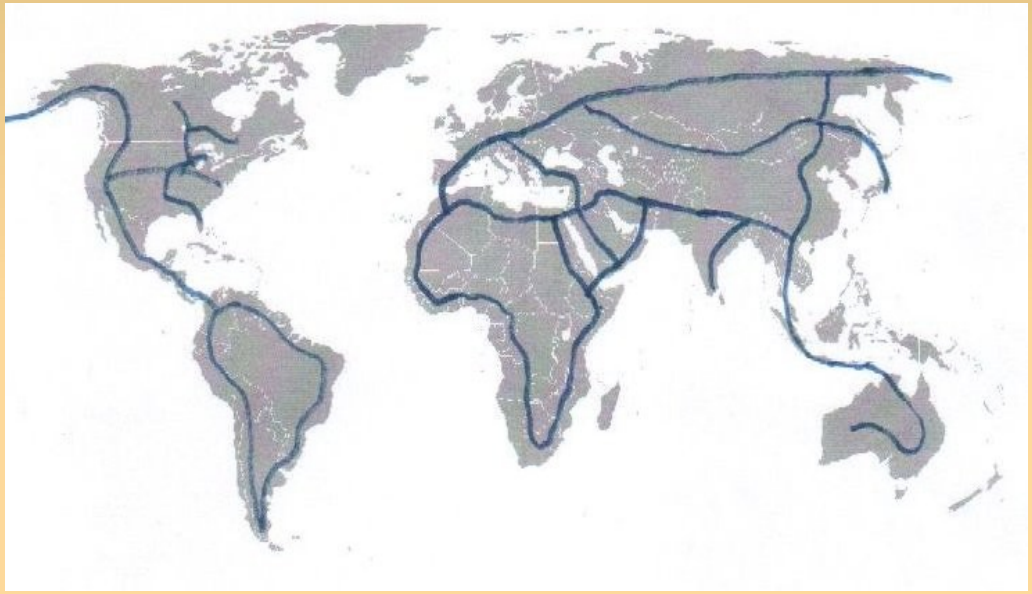
Phase 3

The African Desert for Europe, Africa and Middle East

The Thar Desert for India.

The Gobi Desert for China, Japan and Siberia.

The US Deserts,Mexican deserts for The American Continent.



Third Phase: Completion of the global electrical grid and installation of solar power plants in different deserts. Production of hydrogen all around the world. Supervision under UN.

Source: Science. 1. Nov. 2002. Vol.298. No. 5595
pp.981-987. Doi: 10.1126/science.1072357

The End