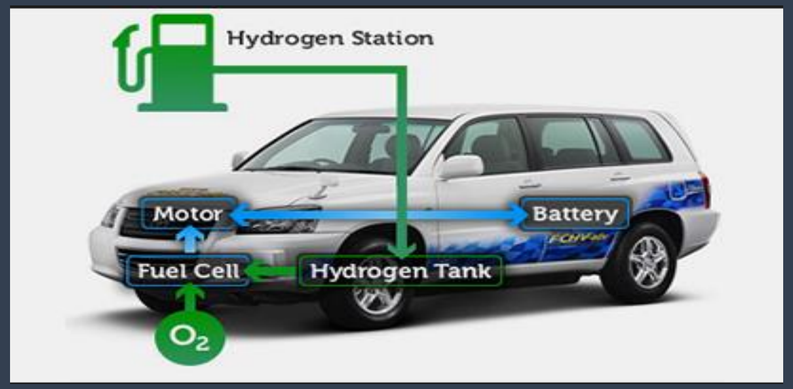
Hydrogen, the ultimate source of clean fuel / energy.



Hydrogen is the universal solution to solve the many energy ,water shortage and environmental challenges the world is facing.

Dr. Mohamed El Sawy

Brief
Dr. Mohamed A. El Sway

Dr. Mohamed A. El-Sawy, more than 39 professional Chemical Engineering experience in "Global Energy - Oil, Gas, Coal & Renewable";

- ✓ *14 years in Strategies Development and Implementation , Performance Management and Projects Planning .*
- ✓ *22 years in Chemical Engineering Design, Operation & Management of Major Capital Projects of Oil Refining & Gas Processing -Davy Power Gas, ENPPI (Former C. F. Braun Egypt) & KNPC – Kuwait National Petroleum Co.*

Doctorate (PhD 1978) in Chemical Engineering from University of Surrey, England, Fellow Member of the British Institution of Chemical Engineers and Member of American Institution of Chemical Engineers (AIChE).

Contents

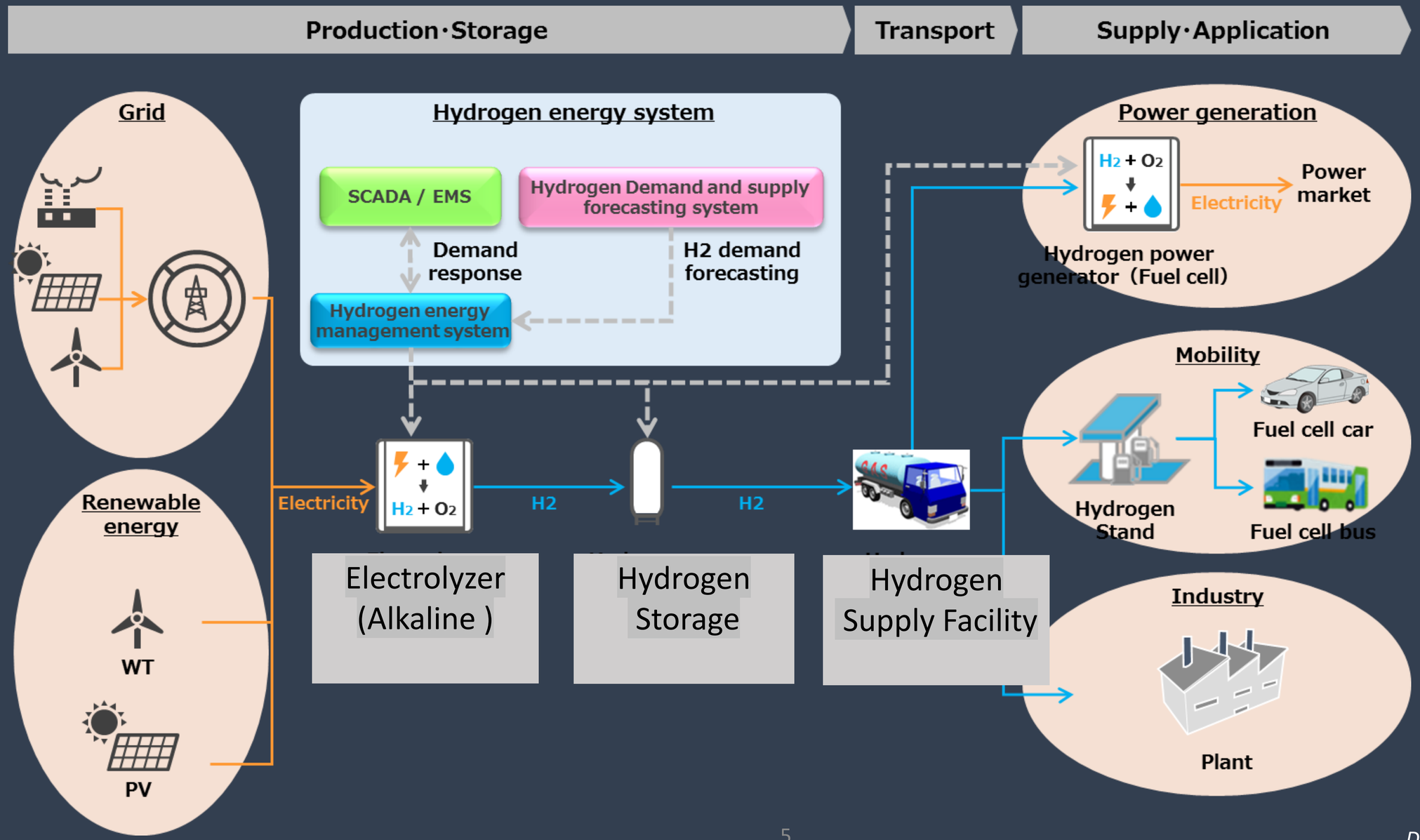
Renewable is & should be Egypt National Project.

Challenges facing the World

- ✓ *Commercial & Price Competitive Sustainable Renewable Energy / Fuel Supply.*
- ✓ *Electric Grid Stability / Renewable Energy Storage.*
- ✓ *Shortage of Drinking / Portable Water.*
- ✓ *Global Warming / Protect Environment.*

The answer to the above World Challenges lays is in the Sun , Wind (Renewable Energy) , Oceans /Seas & the Electrolysis of Sea water for the Production of Hydrogen

Toshiba, Tohoku Electric Power and Iwatani Large Hydrogen Energy System



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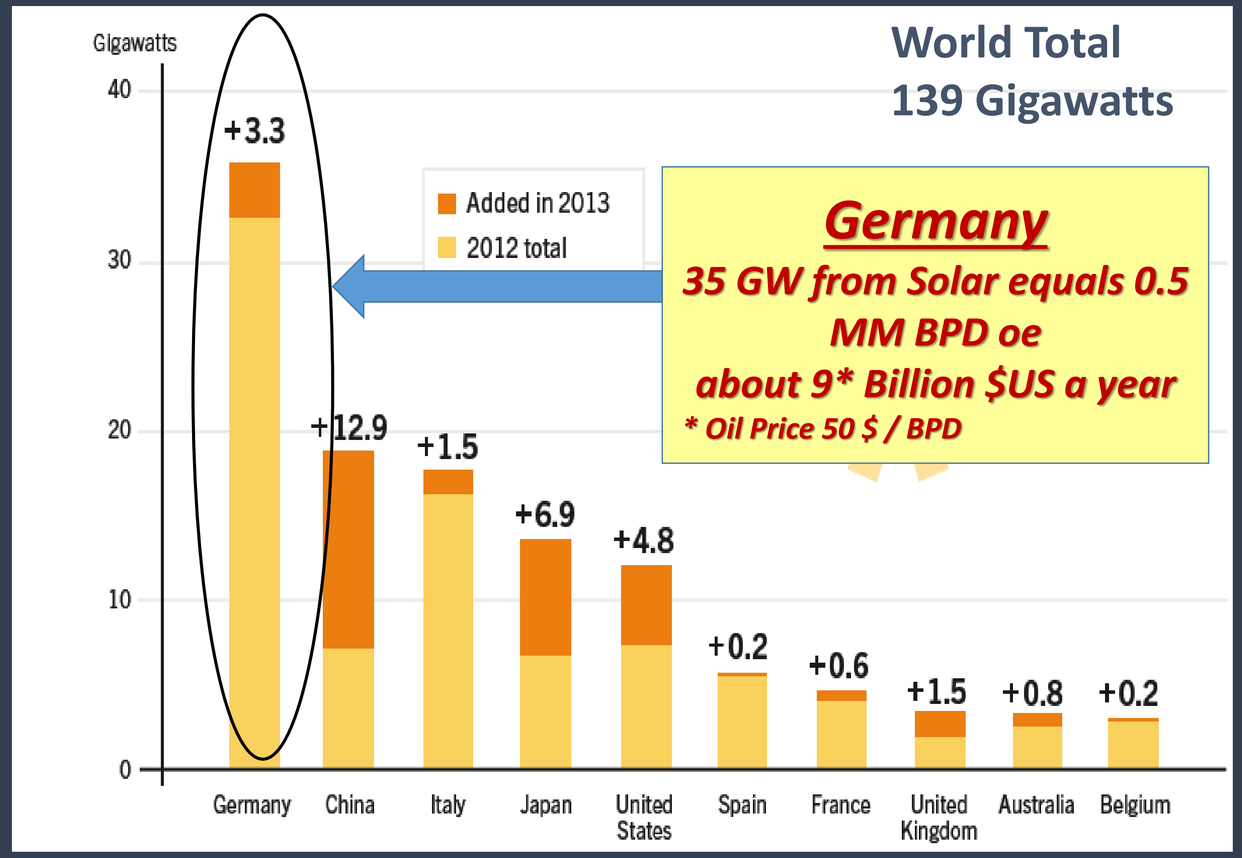
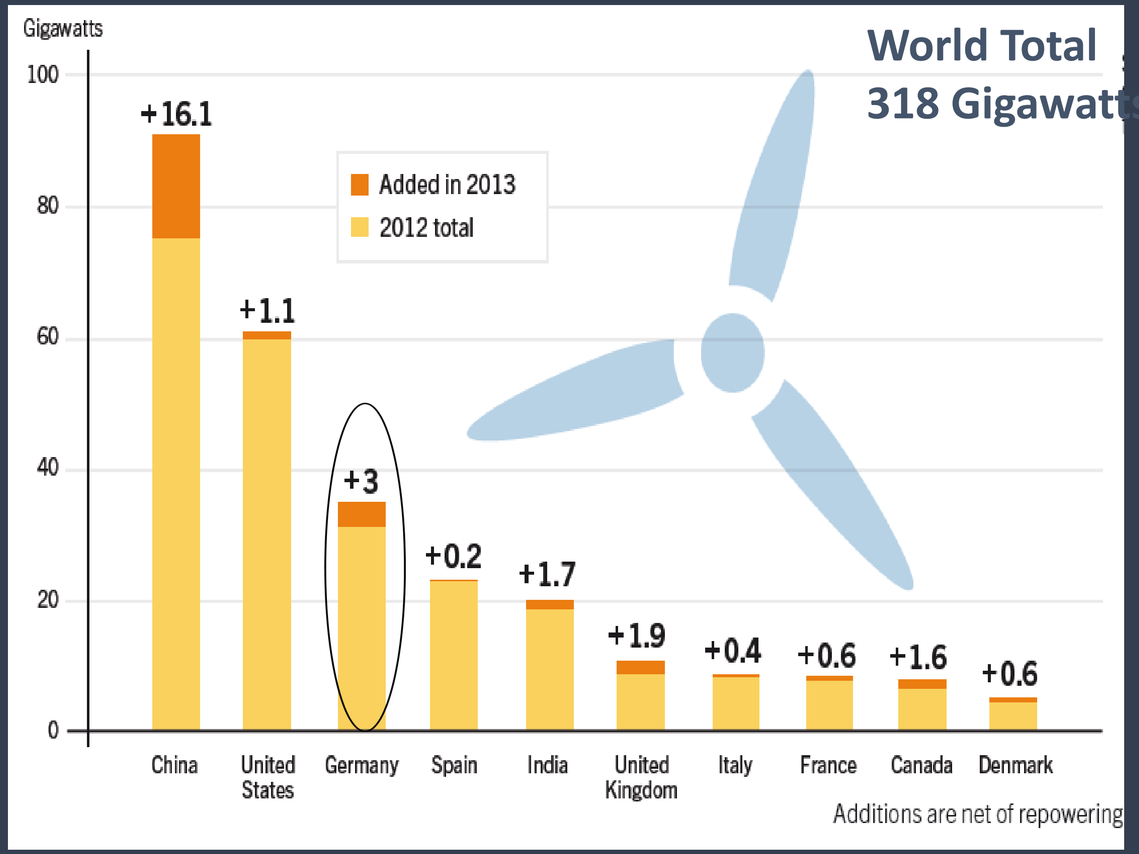
Renewable is & should be Egypt National Project.

Renewable Energy

In the Time Magazine Oct. 1st , 2012 "5 Ideas that are changing the world – by Bill Clinton" page 29 Quote "Germany, where the sun shine on average as much as it does in London, reportedly set the world record for electricity generated from the sun in a single day: 22 gigawatts, or roughly the output of 20 nuclear power plants" Unquote.



Solar PV Capacity and Additions, Top 10 Countries, 2013



Wind Power Capacity and Additions, Top 10 Countries, 2013

Reference: Renewables 2014 Global Status Report

Dr. Mohamed El Sawy

Renewable Energy - Countries / Consumption by Fuel, Energy Mix

Primary energy: Consumption by fuel*

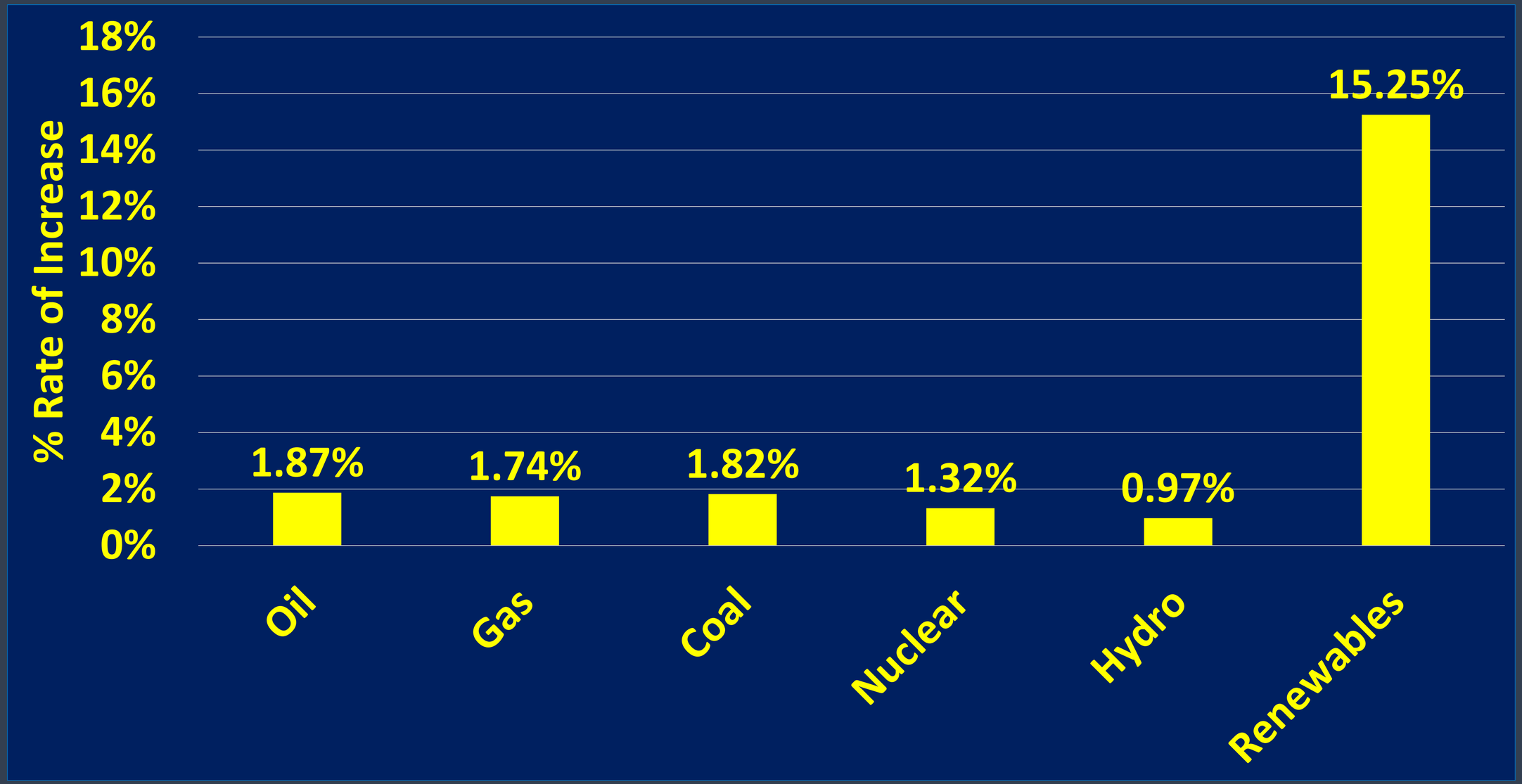
Million tonnes oil equivalent	2014 Oil	Natural gas	Coal	Nuclear energy	Hydro-electricity	Renew-ables	Total	2015 Oil	Natural gas	Coal	Nuclear energy	Hydro-electricity	Renew-ables	Total
US	838.1	692.7	453.8	189.9	59.3	66.8	2300.5	851.6	713.6	396.3	189.9	57.4	71.7	2280.6
Canada	103.3	93.8	21.4	24.2	86.6	6.3	335.5	100.3	92.2	19.8	23.6	86.7	7.3	329.9
Mexico	85.2	78.1	12.8	2.2	8.6	3.0	190.0	84.3	74.9	12.8	2.6	6.8	3.5	185.0
Total North America	1026.6	864.6	487.9	216.3	154.5	76.1	2826.0	1036.3	880.7	429.0	216.1	150.9	82.6	2795.5
France	76.9	32.6	8.7	98.8	14.0	6.5	237.5	76.1	35.1	8.7	99.0	12.2	7.9	239.0
Germany	**110.4**	**64.0**	**78.8**	**22.0**	**4.4**	**32.3**	**311.9**	**110.2**	**67.2**	**78.3**	**20.7**	**4.4**	**40.0**	**320.6**
Greece	14.4	2.4	6.7	–	1.0	1.7	26.3	14.8	2.5	5.7	–	1.3	1.9	26.3
Hungary	6.5	7.5	2.2	3.5	0.1	0.6	20.5	7.0	8.0	2.2	3.6	0.1	0.7	21.5
Ireland	6.5	3.7	2.0	–	0.2	1.3	13.7	6.9	3.8	2.2	–	0.2	1.6	14.6
Italy	55.8	50.7	13.1	–	13.1	14.1	146.8	59.3	55.3	12.4	–	9.9	14.7	151.7
Algeria	18.2	33.7	0.2	–	†	†	52.2	19.3	35.1	0.2	–	†	†	54.6
Egypt	38.3	43.2	0.7	–	3.0	0.3	85.5	39.2	43.0	0.7	–	3.0	0.4	86.2
South Africa	29.3	4.5	90.1	3.3	0.2	0.6	128.0	31.1	4.5	85.0	2.4	0.2	1.0	124.2
Other Africa	91.4	34.1	11.4	–	23.8	1.8	162.6	93.5	39.2	11.0	–	23.8	2.4	169.9
Total Africa	177.2	115.6	102.4	3.3	27.0	2.7	428.2	183.0	121.9	96.9	2.4	27.0	3.8	435.0
Total World	4251.6	3081.5	3911.2	575.5	884.3	316.6	13020.6	4331.3	3135.2	3839.9	583.1	892.9	364.9	13147.3
of which: OECD	2033.8	1436.8	1043.2	450.2	317.3	217.9	5499.2	2056.4	1458.9	979.2	447.6	314.6	246.3	5503.1
Non-OECD	2217.7	1644.7	2867.9	125.3	567.0	98.7	[illegible]	2274.9	1676.3	2860.7	135.5	578.3	[illegible]	7644.2
European Union	591.2	346.0	267.2	198.5	84.5	118.3	1605.[illegible]	600.2	361.9	262.4	194.1	76.4	136.0	1630.9
CIS	198.7	509.0	162.6	61.5	53.3	0.6	985.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.6	950.4

*In this review, primary energy comprises commercially-traded fuels, including modern renewables used to generate electricity.
†Less than 0.05.
Note: Oil consumption is measured in million tonnes; other fuels in million tonnes of oil equivalent.

زيادة في الطاقة المتجددة إلى 7.3 من 6.3 مليون برميل مكافئ في الي اليوم

Reference: BP Statistical Review of World Energy - June 2016

Renewable Energy : % increases of the different fuels from 2014 to 2015.



Reference: BP Statistical Review of World Energy - June 2016

Dr. Mohamed El Sawy

Renewable Energy - Lead Countries / Consumption by Fuel, Energy Mix

Million Tons Oil Equivalent (2015)

	Land (Sq. Km)	Population Millions	Oil	Gas	Coal	Nuclear	Renewable
Germany	357,000.	82	111	67	78	20.7	40
France	552,000	57.9	76	35	9	99	8
Spain	504,782	39.2	60.5	15	14	13	15.4
Egypt	**1,001,449**	**90**	**39**	**43**	**0.7**	**-**	**0.4**

Egypt have to embark on strategy to have the right energy mix. This strategy shall have Targets with initiatives , projects and time schedule to attain these Targets , mostly ensure the required energy security for the Nation.

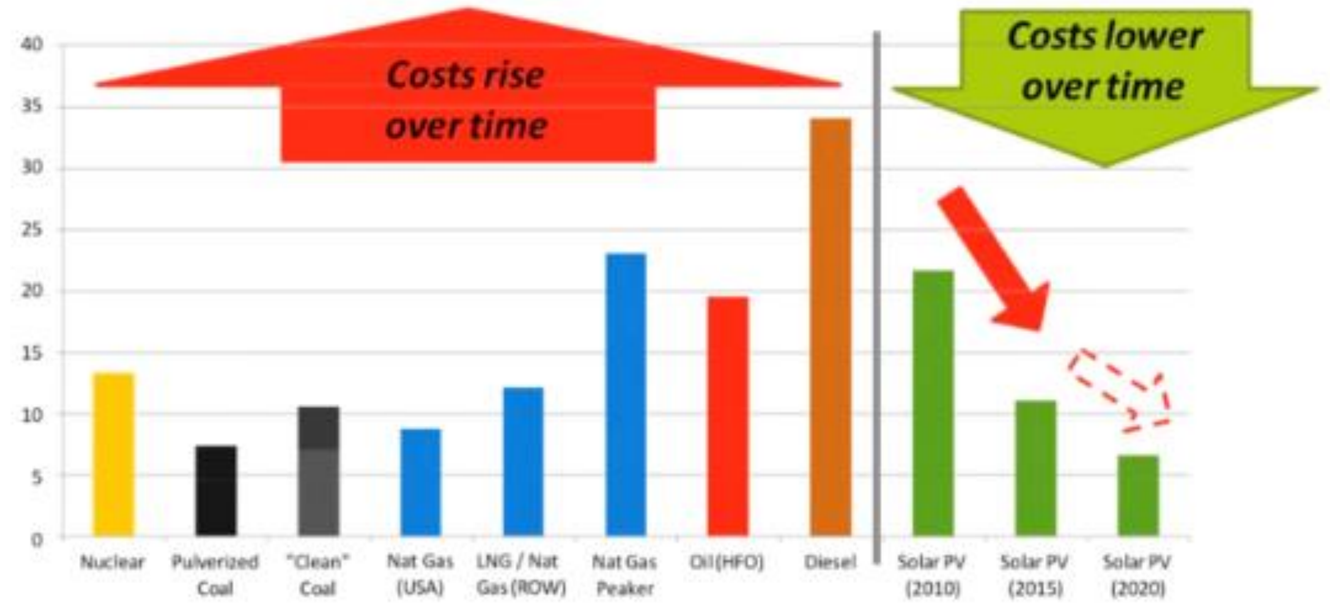
Reference: BP Statistical Review of World Energy - June 2016

Dr. Mohamed El Sawy

Renewable Energy –Comparative Unsubsidized Wholesale Prices for Electricity(U.S. $ cents/kWh)

We are already working on solar projects that can beat fossil fuel prices, and this will only continue to be the norm

"Unsubsidized" Wholesale Price for Electricity* (U.S. $ cents/kWh)



8minutenergy RENEWABLES

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Source: SNL Financial LC, Electric Utilities Operational Statistics 2013, 8me analysis
* Excludes any carbon taxes or other environmental costs

Renewable Energy – Facts/Conclusions.

- ✓ *Solar PV / Wind Energy is providing electricity in Giga Watt scale commercially competing to other main conventional Electric Power Generation.*
- ✓ *Solar PV / Wind Energy is the way to address big part of Egypt trade imbalance associated with fuel importing bill . Most important, money stays in and contributes to our growth , create new jobs and increase the wealth of the Nation.*

Solar PV Energy Technology is the Technology which Egypt can acquire & develop compared to other Technologies.

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Renewable Energy - The way to Face Future Challenges.

Be among the forefront of the developed nations.

Renewable is & should be Egypt National Project.

Electricity Grid Stability / Renewable Energy Storage

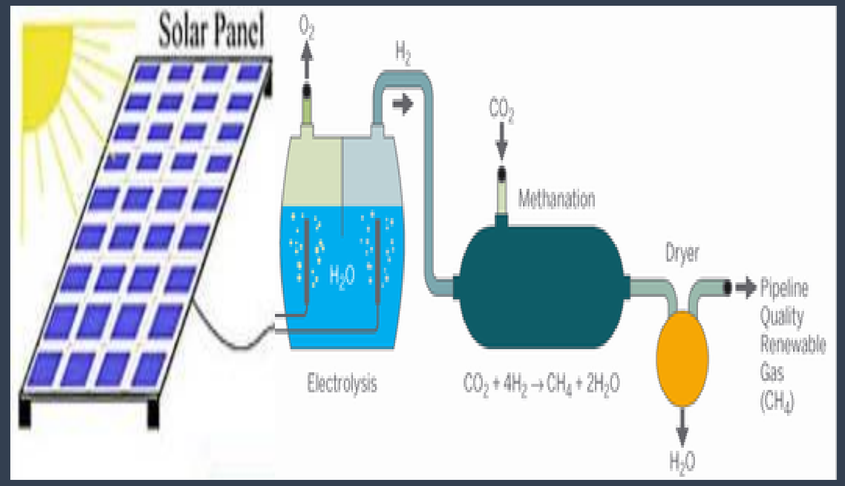
However, Energy sources such as solar and wind power are inherently variable.

Electricity Grid Stability can be realized if part of the capacity of a wind farm or solar power could be stored i.e. be available at any time regardless of the weather.

Electrolysers provide the means for doing so. A certain proportion of the solar power output could be diverted through large electrolysers located on site. The resultant hydrogen can then be stored at the point of production and used to fuel power plants / H_2 Fuel Cell that run on demand to dispatch electricity to the grid

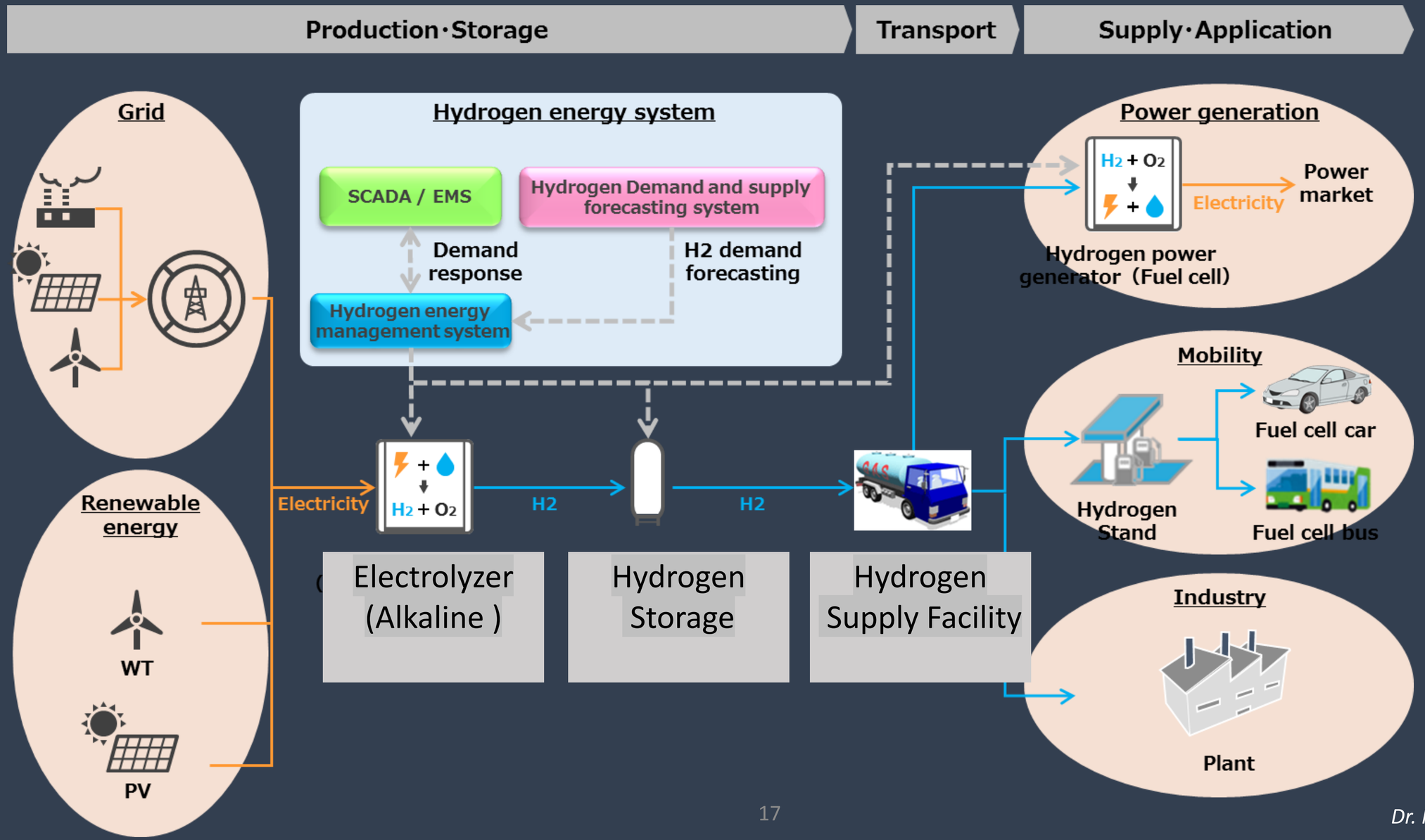
Electricity Grid Stability / Electrolysis

- ✓ *One of the chief advantages of electrolysis is that it can be applied at great range of scales.*
- ✓ ***Electrolysers have a broad operational range (anywhere between 0% to 100% of rated output or higher for short periods) and can respond very quickly to changes in input (often in less than a second) they have excellent dynamic capacity.***
- ✓ *Using renewable electricity to drive water electrolysis and produce hydrogen in large quantities as an energy storage medium is in fact one of the most viable option available to us.*

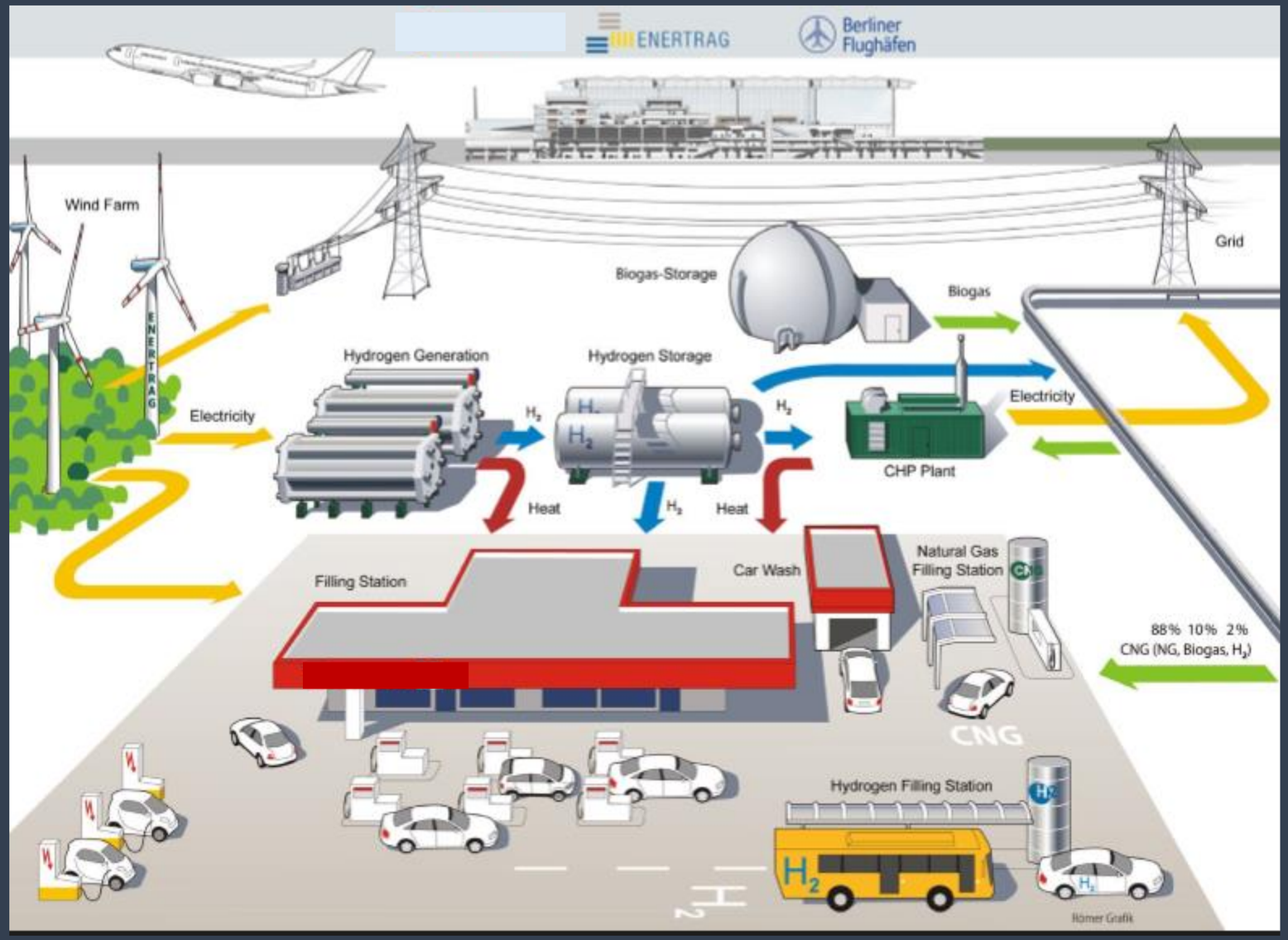


Reference: FuelCellToday – May 2013

Toshiba, Tohoku Electric Power and Iwatani Start Development of Large Hydrogen Energy System



Electricity Grid Stability / Renewable Energy Storage



BERLIN BRANDEBURG AIRPORT PROJECT

Gas transmission pipelines offer a significantly more effective means of moving large quantities of energy over distances than power lines do and are subject to lower losses, as are distribution pipelines

Reference: FuelCellToday – May 2013

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Be among the forefront of the developed nations.

Renewable is & should be Egypt National Project.

Hydrogen's greatest asset is its potential to be the ultimate source of clean energy & 100% Pure Water

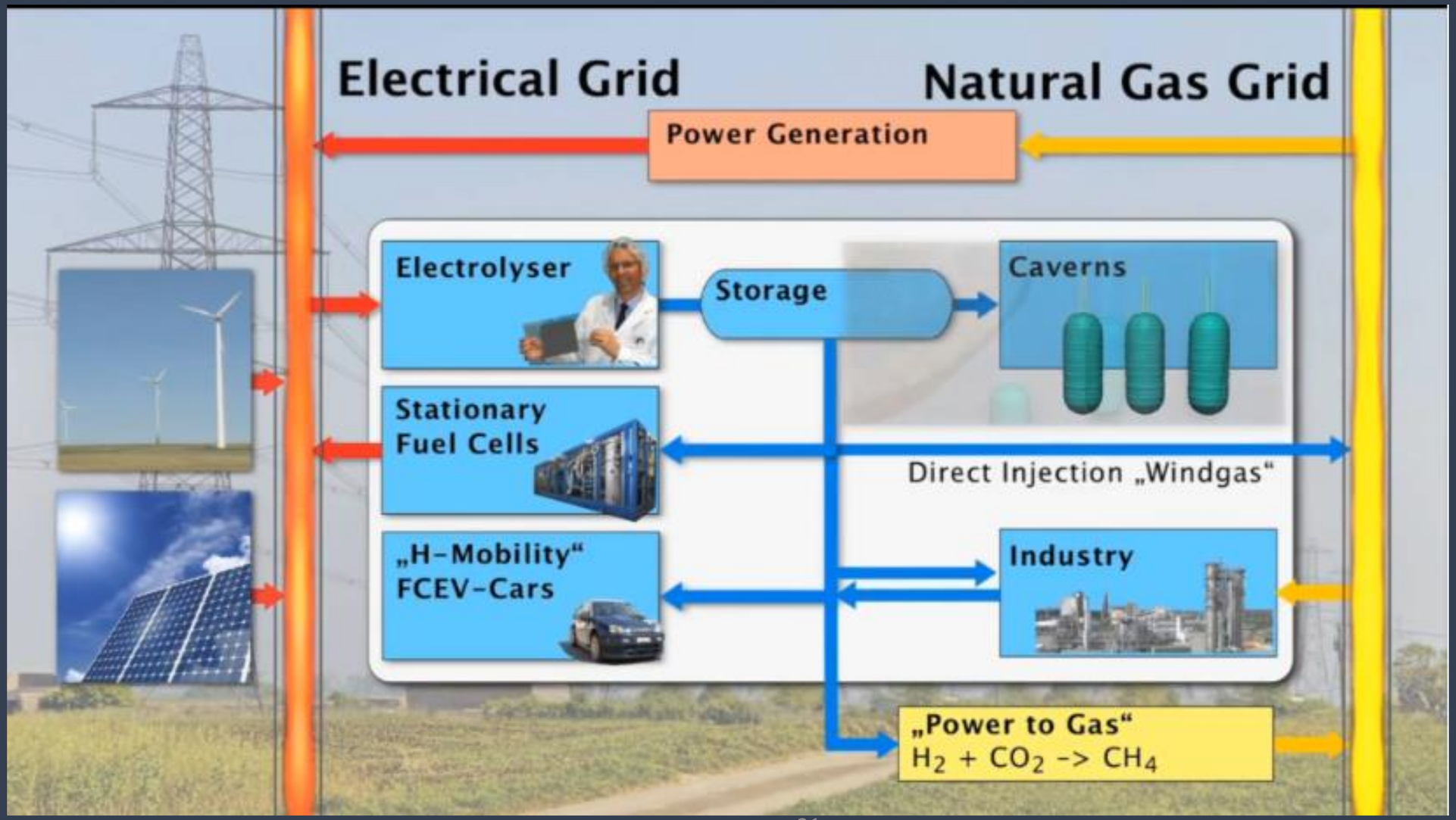
Hydrogen is the universal solution and installing electrolysers in large numbers is the way to solve the many energy and environmental challenges the world is facing plus the fact that it can produce water.

The manifold benefits of hydrogen make it one of the most attractive - if not the only - energy carries, with its ability to connect the energy silos of electricity, heat, transportation and industrial uses in a way no other energy storage solution can if it is thermal or batteries etc.

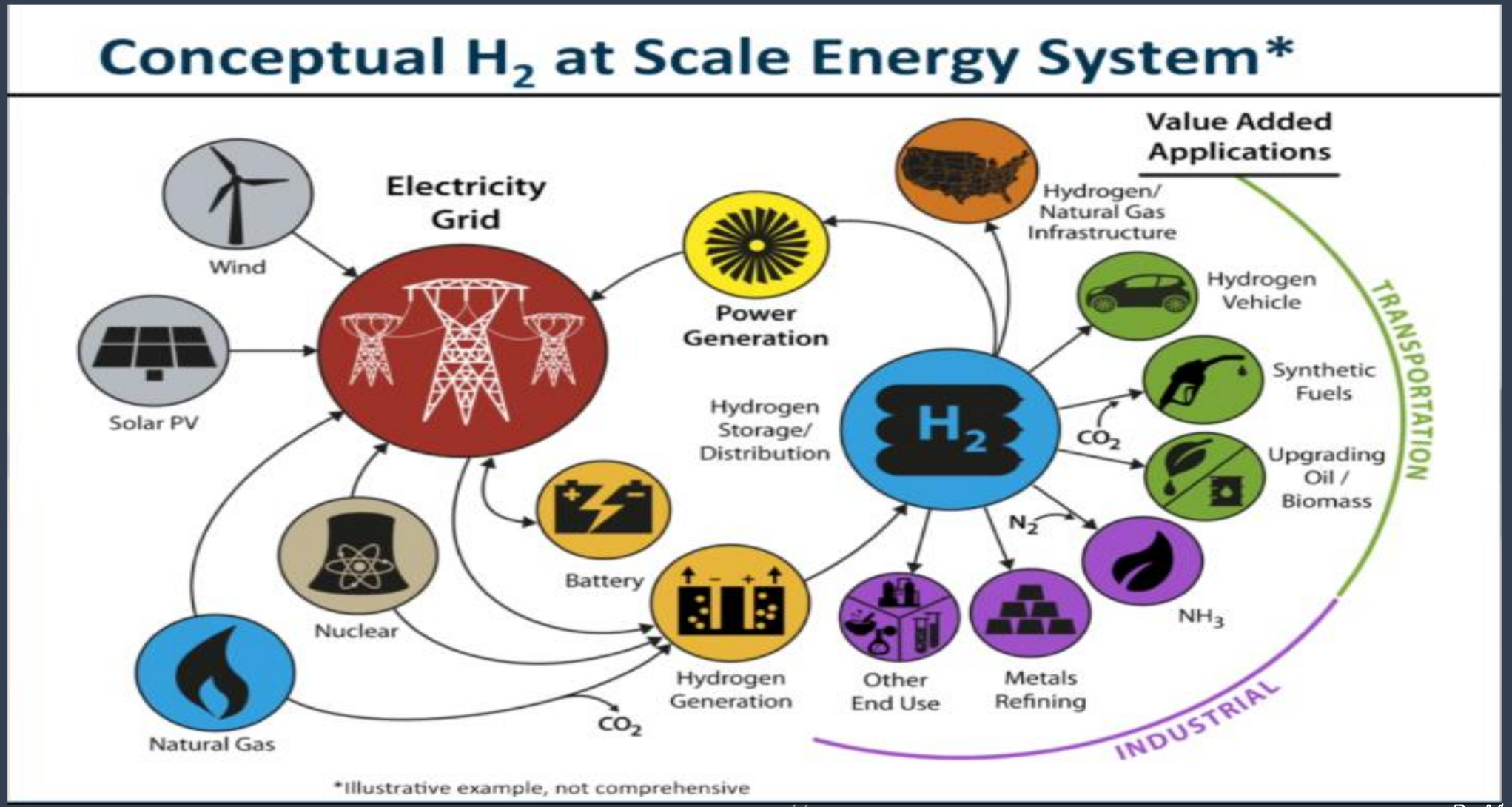
Sun is universal, no country no person can claim ownership

Reference: FuelCellToday – May 2013

Hydrogen's greatest asset is its potential to be the ultimate source of clean energy & its ability to connect the energy silos of electricity, heat, transportation and industrial uses



Hydrogen's greatest asset is its potential to be the ultimate source of clean energy & its ability to connect the energy silos of electricity, heat, transportation and industrial uses



Hydrogen's greatest asset is its potential to be the ultimate source of clean energy & 100% Pure Water

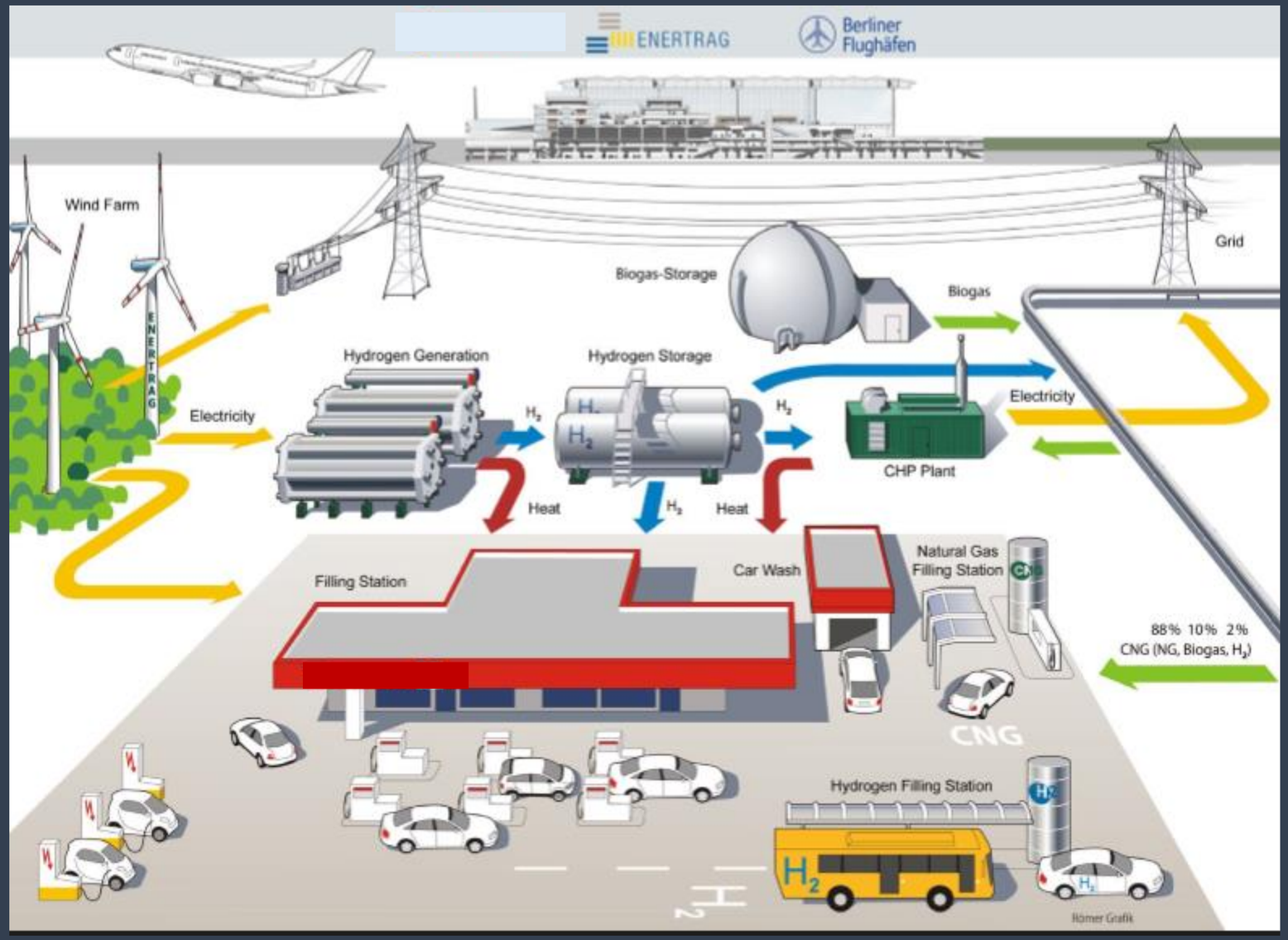
HUGE Benefit of Hydrogen Technology:

100% Pure Water

Widespread use of hydrogen fuel cells could potentially
SOLVE
the world's drinking-water problem.

Dr. Mohamed El Sawy

Electricity Grid Stability / Renewable Energy Storage



BERLIN BRANDEBURG AIRPORT PROJECT

Gas transmission pipelines offer a significantly more effective means of moving large quantities of energy over distances than power lines do and are subject to lower losses, as are distribution pipelines

Reference: FuelCellToday – May 2013

Supplied artist's impression of a liquid hydrogen carrier from ship-builder Kawasaki Heavy Industries

Australia and Japan signed a deal in January 2017 to ship liquid hydrogen in bulk from Victoria, in what will be a world first. A pilot project is expected to start in 2020.

Toshiba completes solar-powered hydrogen production/storage system at hotel

Mar. 27, 2016

TOKYO Toshiba Corp says its "H2One" stand-alone hydrogen energy supply system has been completed in the "Henna (Weird) Hotel," .

In summer, when there are long hours of sunlight, surplus solar electricity is used to electrolyze water with the hydrogen production equipment, and the produced hydrogen is stored in the tank. In winter, the stored hydrogen is used to generate electricity with the pure hydrogen fuel cell. As a result, one hotel building (12 rooms) can be powered by using only water and solar power throughout the year.

Norway takes on Australia in bid to fulfill Japan's hydrogen society dream

Apr 30, 2017

- ✓ *OSLO/MELBOURNE/TOKYO – Norway and Australia are racing each other to show they can supply Japan with hydrogen.*
- ✓ *While Australia has planned to derive liquid hydrogen from brown coal for some time, Norway could steal a march if a pilot project producing the fuel using renewable energy — a climate-friendly method more in keeping with Japan's aims — is cheaper.*
- ✓ *Norway Nel Hydrogen's market development vice president, Bjorn Simonsen, said in an interview that the company aims to deliver liquefied hydrogen to Japan for a minimum ¥24 per normal cubic meter (about 21 $/MMBTU). A study on the plan is due to be completed in 2019.*
- ✓ *Kawasaki Heavy Industries (KHI) estimates that hydrogen from Australia costs about ¥29.8/nm3 (about 26 $/MMBTU) and the company plans to establish a global LH2 supply chain like that for liquefied natural gas.*

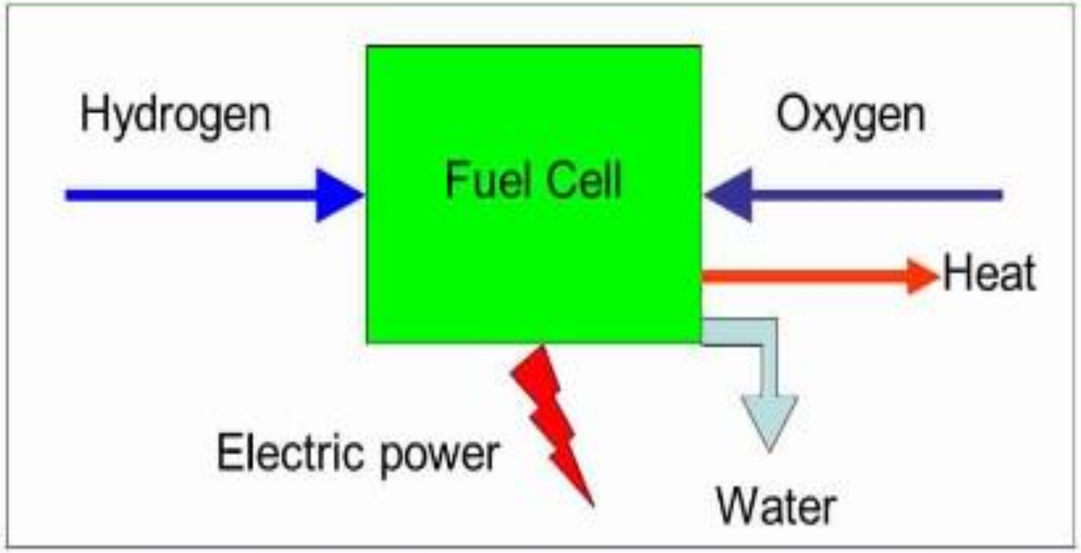
Japan's Hydrogen Society Vision.

- ✓ *Prime Minister Shinzo Abe is pushing his vision to end the energy crisis that has plagued the nation since the 2011 Fukushima meltdowns, which led to a dramatic drop in electricity production from its nuclear plants.*
- ✓ *Japan's annual hydrogen and fuel cell market is forecast to hit ¥1 trillion ($9 billion) in 2030 and ¥8 trillion ($72 billion) in 2050, according to the industry ministry.*
- ✓ *Kawasaki Heavy Industries (KHI) is developing a supply chain to back Abe's initiative, which will be showcased when Tokyo hosts the 2020 Olympic Games.*

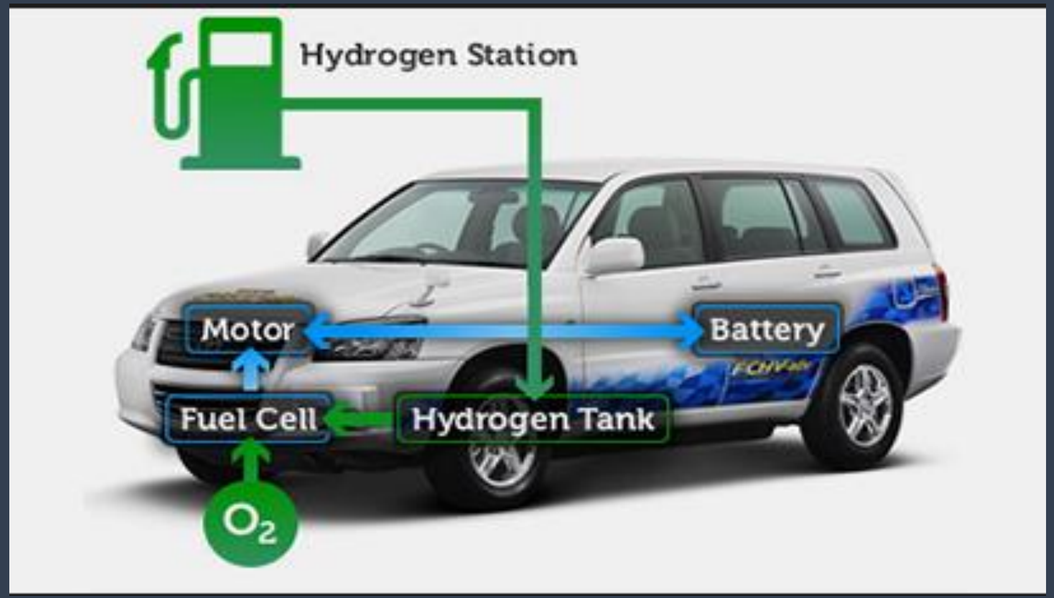
Hydrogen Fuel Cell Concept

Fuel Cell Technology: Basics and Applications © Prof. Ajay K. Prasad University of Delaware

What is a Fuel Cell?



- A fuel cell combines fuel and oxidant electrochemically to produce electricity
- Two to three times more efficient that an internal combustion engine
- Fuel cell stack is quiet, has no moving parts, produces *zero emissions*



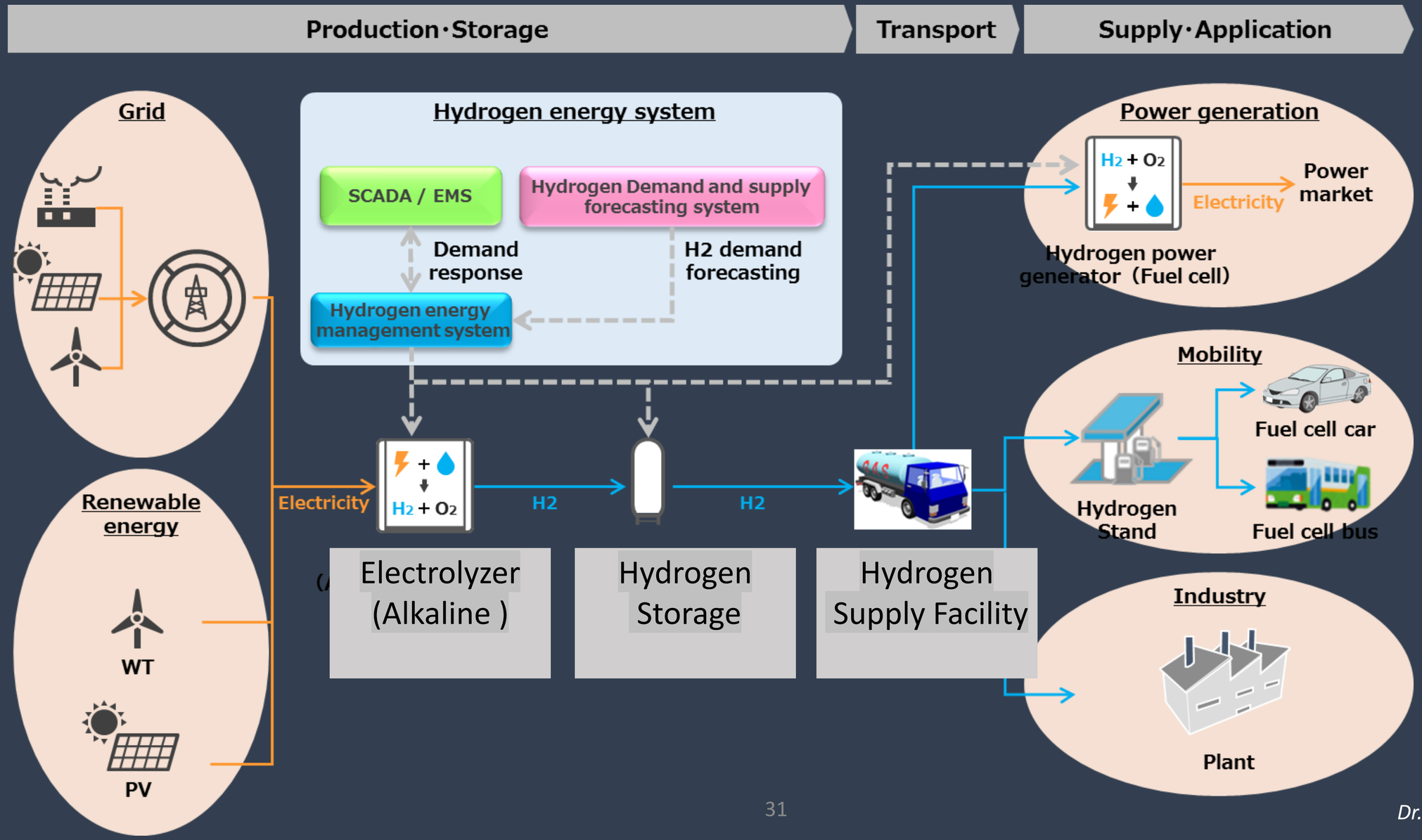
***Toshiba**, Tohoku Electric Power and Iwatani Start Development of Large Hydrogen Energy System*

10 Aug, 2017

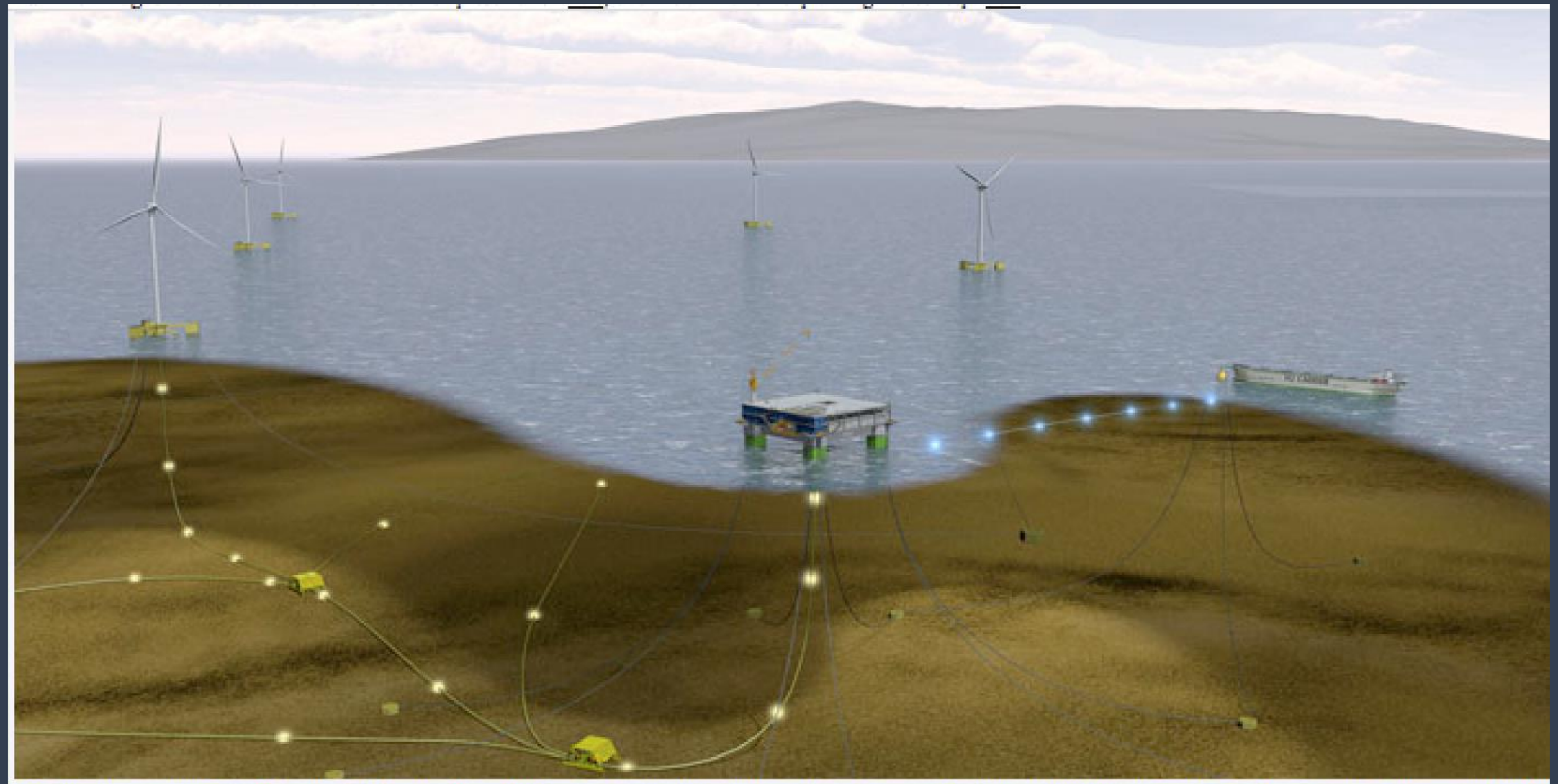
TOKYO—Toshiba Corporation, Tohoku Electric Power Co., Inc. and Iwatani Corporation announced that they will construct and operate a large-scale hydrogen energy system in Namie-cho, Fukushima prefecture, based on a 10,000 kW class hydrogen production facility. The system will use hydrogen to offset grid loads, and deliver hydrogen to locations in Tohoku and beyond, and will seek to demonstrate the advantages of hydrogen as a solution in grid balancing and as a hydrogen gas supply.

That project has won a positive evaluation from Japan's New Energy and Industrial Technology Development Organization (NEDO).

Toshiba, Tohoku Electric Power and Iwatani Start Development of Large Hydrogen Energy System



JAPAN New Era (JIDAI) Project for production hydrogen from Ocean wind & sea water



Jidai concept uses floating offshore wind turbines to harvest hydrogen from purified seawater, using a process of electrolysis. Click the image to view a larger version. (Image credit: DNV

Japan looking to lead in exporting renewable energy tech. to emerging economies

Jul 13, 2017

- ✓ *The Japanese government plans to export its expertise in renewable energy technologies solar and hydrogen power to emerging economies. Japan plans is to use the export of the technologies to strengthen its strategic ties with the destination countries.*
- ✓ *The Ministry of Economy, Trade and Industry and the Foreign Ministry are expected to make arrangements in the near future to develop specific plans, according to the source. The ministries' primary challenge is likely to be assuaging developing countries' concerns about the costs of renewable energy infrastructure.*
- ✓ *Japan is currently pursuing the production of hydrogen using renewable sources in Fukushima. The government plans to start up one of the world's biggest hydrogen production facilities by 2020 and take the technologies for transporting and storing hydrogen overseas in future.*

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Be among the forefront of the developed nations.

Renewable is & should be Egypt National Project.

Renewable Energy – Estimated Cost of Hydrogen producetion from Water Electrolysis ; Economics , Fuel Comparative Unit Prices

- ✓ *The production cost of Hydrogen from Water Electrolysis (at Renewable Solar price of $ 0.025 per Kilo Watt Hr. -2016 prices) is estimated below $ 1.5 for each 1 Kilo gram Hydrogen.*
- ✓ *On the basis of the estimated cost of Hydrogen production from water electrolysis, it is calculated that the cost of one million BTU Hydrogen will be less than $ 10 and this price is very competitive to the current LNG price of $10 per million BTU.*
- ✓ *If the forecasted reduction of 50 to 60% in the price of Solar PV electricity is realized due to the expected technology advancement by 2025 and the large scale Solar plants - economy of scale – mass production of the different equipments, then the price of hydrogen produced from water electrolysis will be even competitive to Natural Gas.*
- ✓ *At the current prices of Oil - $ 50 / bbl. – the price of one Kilogram Hydrogen is less than the price of one Kilogram of Gasoline or Diesel or ATK. Needless to say that the heat content of one Kilogram Hydrogen is nearly three times that of Gasoline or Diesel or ATK._*

Renewable Energy – Estimated Cost of Hydrogen production from Water Electrolysis

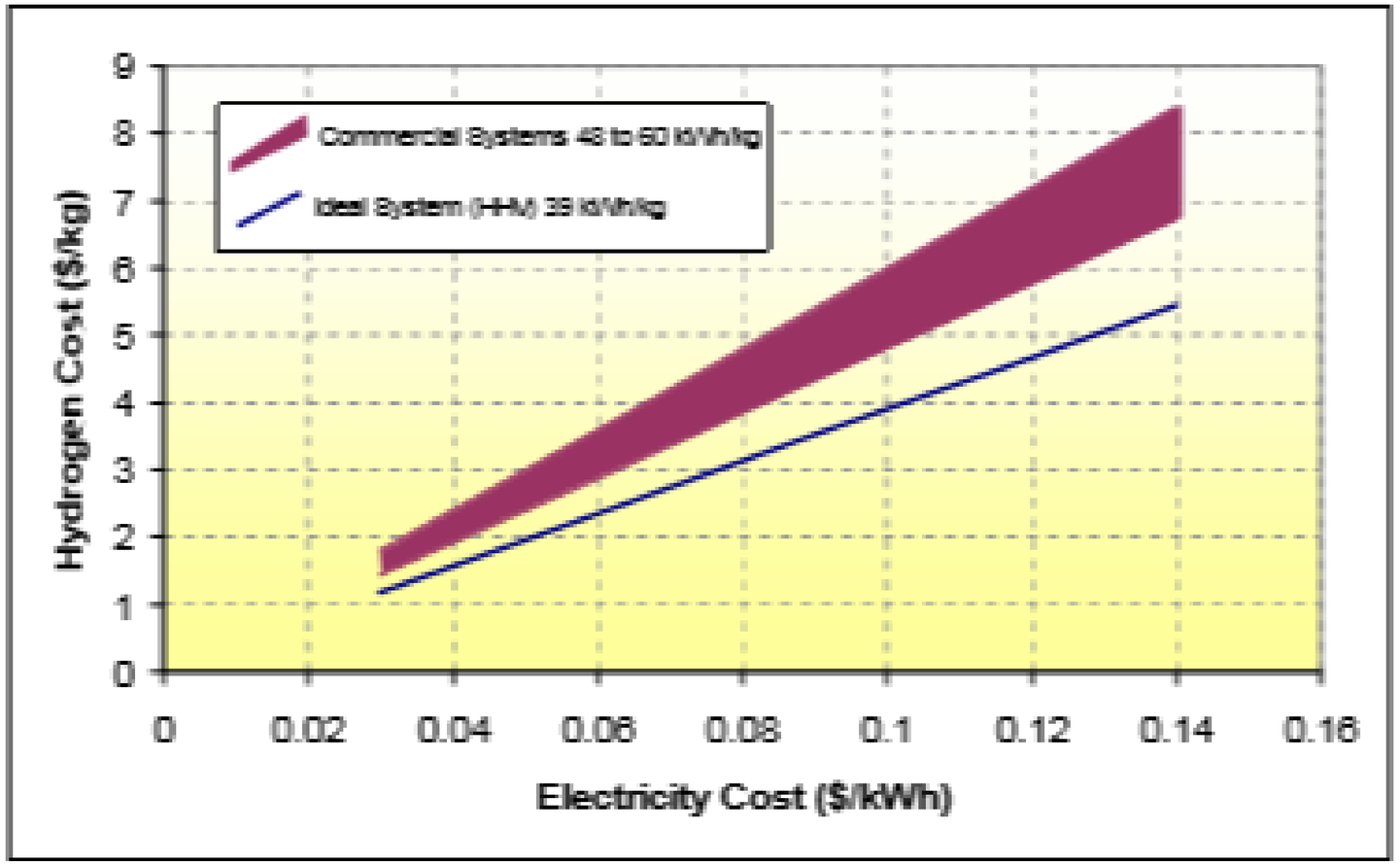


Figure 3. Influence of electricity cost alone on hydrogen cost (without capital, operating, or maintenance costs)

Reference: NREL : 2009 State-of-the-Art Hydrogen Production Cost Estimate Using Water Electrolysis ; Sept. 2009

Renewable Energy – Estimated Cost of Hydrogen producetion from Water Electrolysis

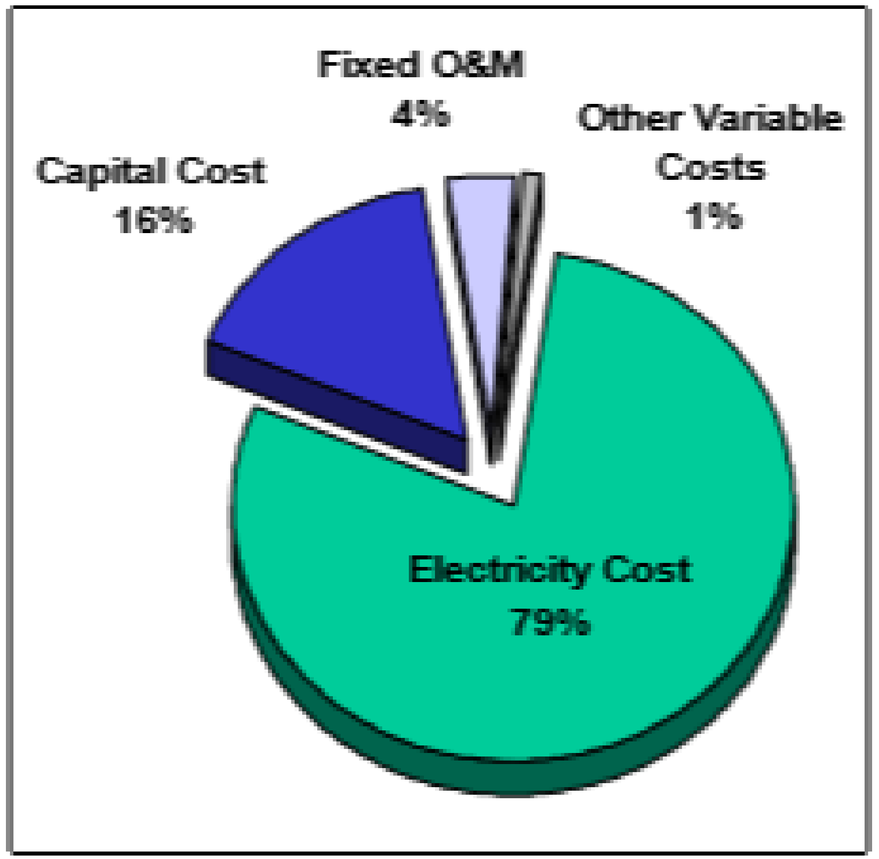
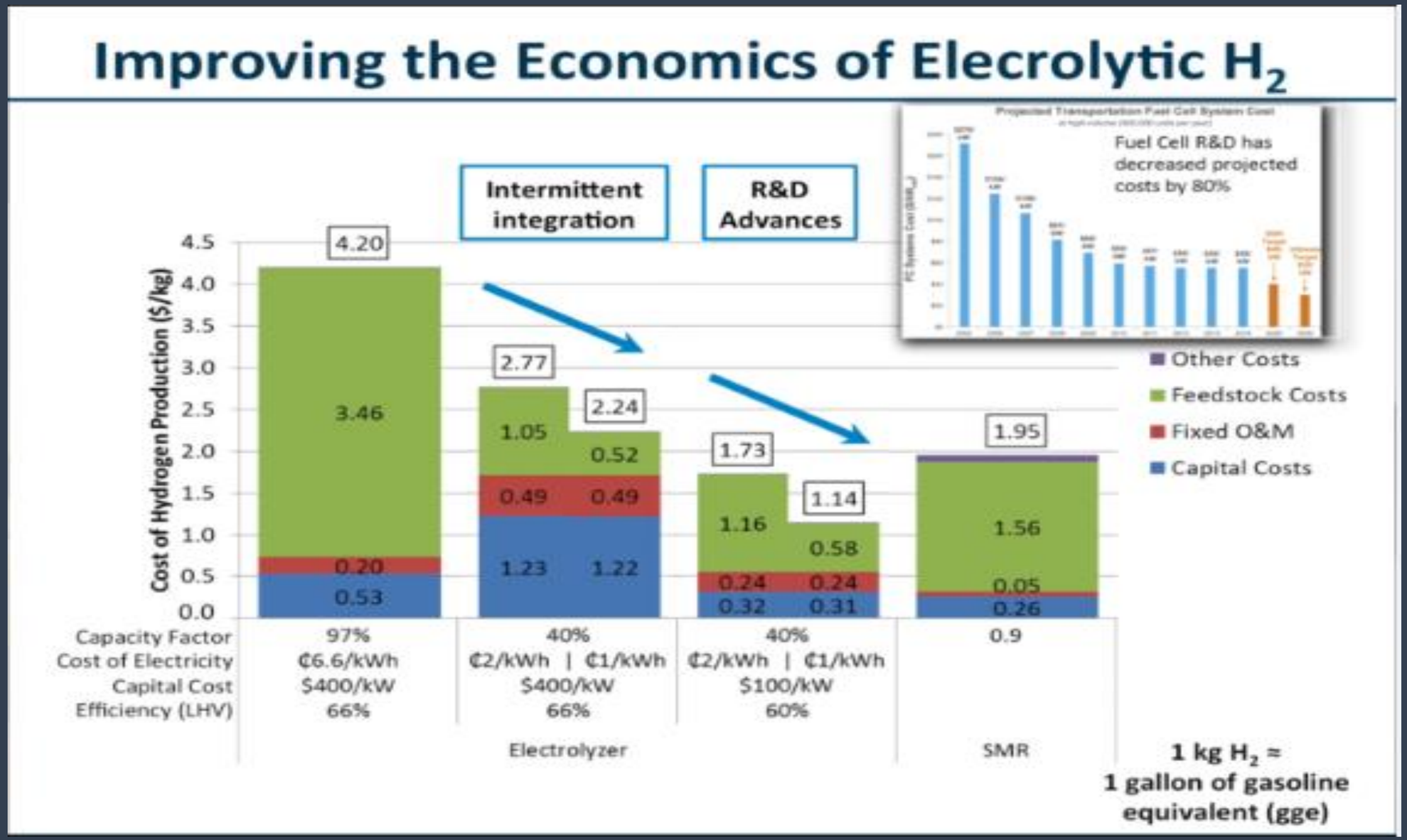


Figure 7. Forecourt production (excluding forecourt C/S/D)—hydrogen cost breakdown

Reference: NREL : 2009 State-of-the-Art Hydrogen Production Cost Estimate Using Water Electrolysis ; Sept. 2009

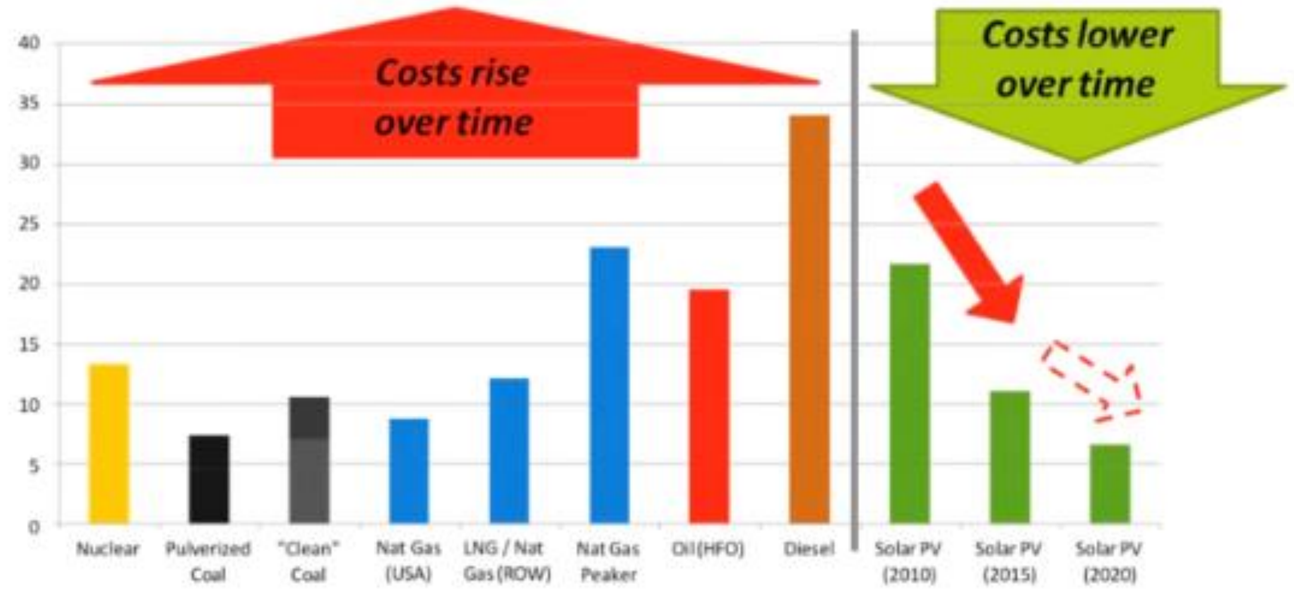
Renewable Energy –Comparative Prices for Production of 1 kg H2 from Electrolysis and Methane Steam Reforming



Renewable Energy –Comparative Unsubsidized Wholesale Prices for Electricity(U.S. $ cents/kWh)

We are already working on solar projects that can beat fossil fuel prices, and this will only continue to be the norm

"Unsubsidized" Wholesale Price for Electricity* (U.S. $ cents/kWh)



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Source: SNL Financial LC, Electric Utilities Operational Statistics 2013, 8me analysis
* Excludes any carbon taxes or other environmental costs

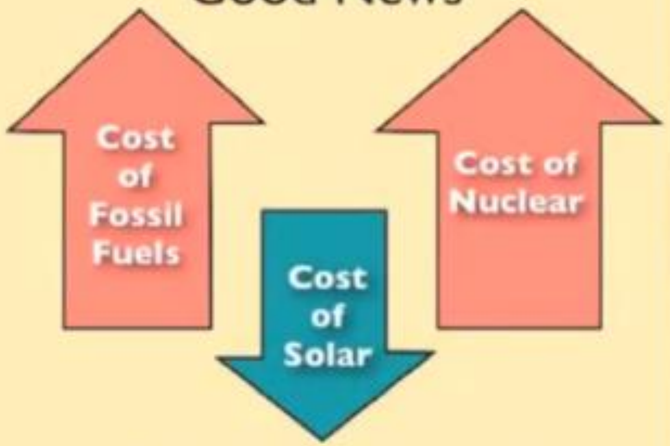
Why Optimism?

Climate Change News

Bad News

97% of climate scientists worldwide now agree that Climate Change is both REAL and HUMAN-CAUSED

Good News



The price of solar energy is FALLING.

"The stone age did not end because they ran out of stones."

Norway takes on Australia in bid to fulfill Japan's hydrogen society dream

Apr 30, 2017

- ✓ *OSLO/MELBOURNE/TOKYO – Norway and Australia are racing each other to show they can supply Japan with hydrogen.*
- ✓ *While Australia has planned to derive liquid hydrogen from brown coal for some time, Norway could steal a march if a pilot project producing the fuel using renewable energy — a climate-friendly method more in keeping with Japan's aims — is cheaper.*
- ✓ *Norway Nel Hydrogen's market development vice president, Bjorn Simonsen, said in an interview that the company aims to deliver liquefied hydrogen to Japan for a minimum ¥24 per normal cubic meter (about 21 $/MMBTU). A study on the plan is due to be completed in 2019.*
- ✓ *Kawasaki Heavy Industries (KHI) estimates that hydrogen from Australia costs about ¥29.8/nm3 (about 26 $/MMBTU) and the company plans to establish a global LH2 supply chain like that for liquefied natural gas.*

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Renewable Energy - The way to Face Future Challenges.

Be among the forefront of the developed nations.

Renewable is & should be Egypt National Project.

Challenges facing Egypt

It is forecasted that Egypt will require an Electric Power Generation Capacity of 135 Giga Watt /hr. by 2035 from current Electric Power Generation Capacity of 44 Giga Watt /hr.

Considering the new / approved added Generation Capacity under different stages from planning to construction and the old units to be phased out , then Egypt will need to add about 100 Giga Watt / hr. Electric Power Generation Capacity over the next 17 years.

This added 100 Giga Watt /hr. Electric Power Generation Capacity will require to import LNG and increase Egypt importing bill by about $ 70 Billion yearly (LNG price is considered $ 10 per million BTU)

Renewable Energy; Benefits

- ✓ *Exporting Hydrogen commercially based on Solar PV / Electrolyzes / hydrogen storage & export, present a great opportunity in closing trade (import / export) imbalance.*
- ✓ *Building 100 Giga Watt commercial scale plant(s) based on solar PV/ electroyser / hydrogen storage and power generation will save about $ 70 Billion yearly fuel importing bill.*
- ✓ *Additional benefits will be the production of about 3 Billion Cubic Meters of the most need water.*
- ✓ *Huge opportunity in establishing Industrial base, Engineering & Contracting and applied R& D in all of the Renewable Energy fields.*

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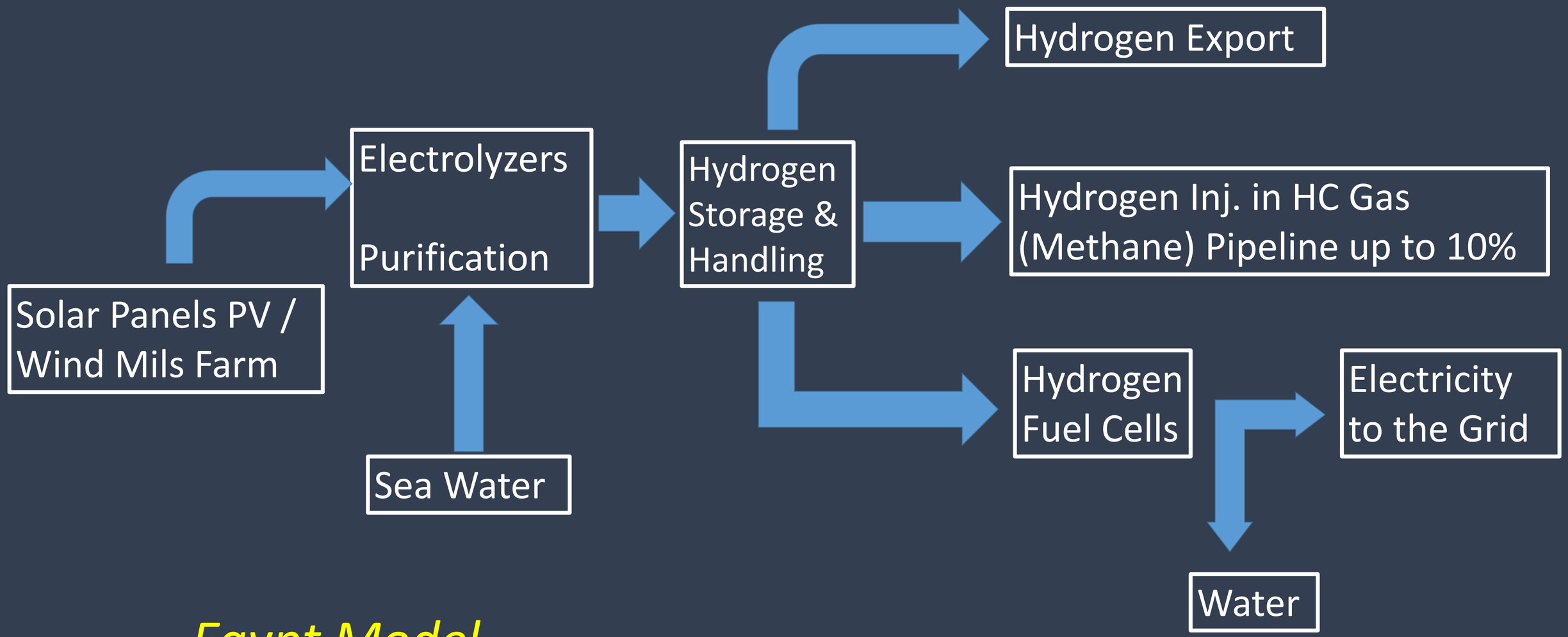
The Way to Face Future Challenges – Renewable Energy

- ✓ *Establish conceptual / front end scheme (Feasibility Study) & Financial Model (Business Model) for commercial scale plant(s) based on solar PV / electrolysis / hydrogen handling, storage & export and power generation by H_2 FuelCell with the economical & operating performance targets / guarantees that can be achieved.*

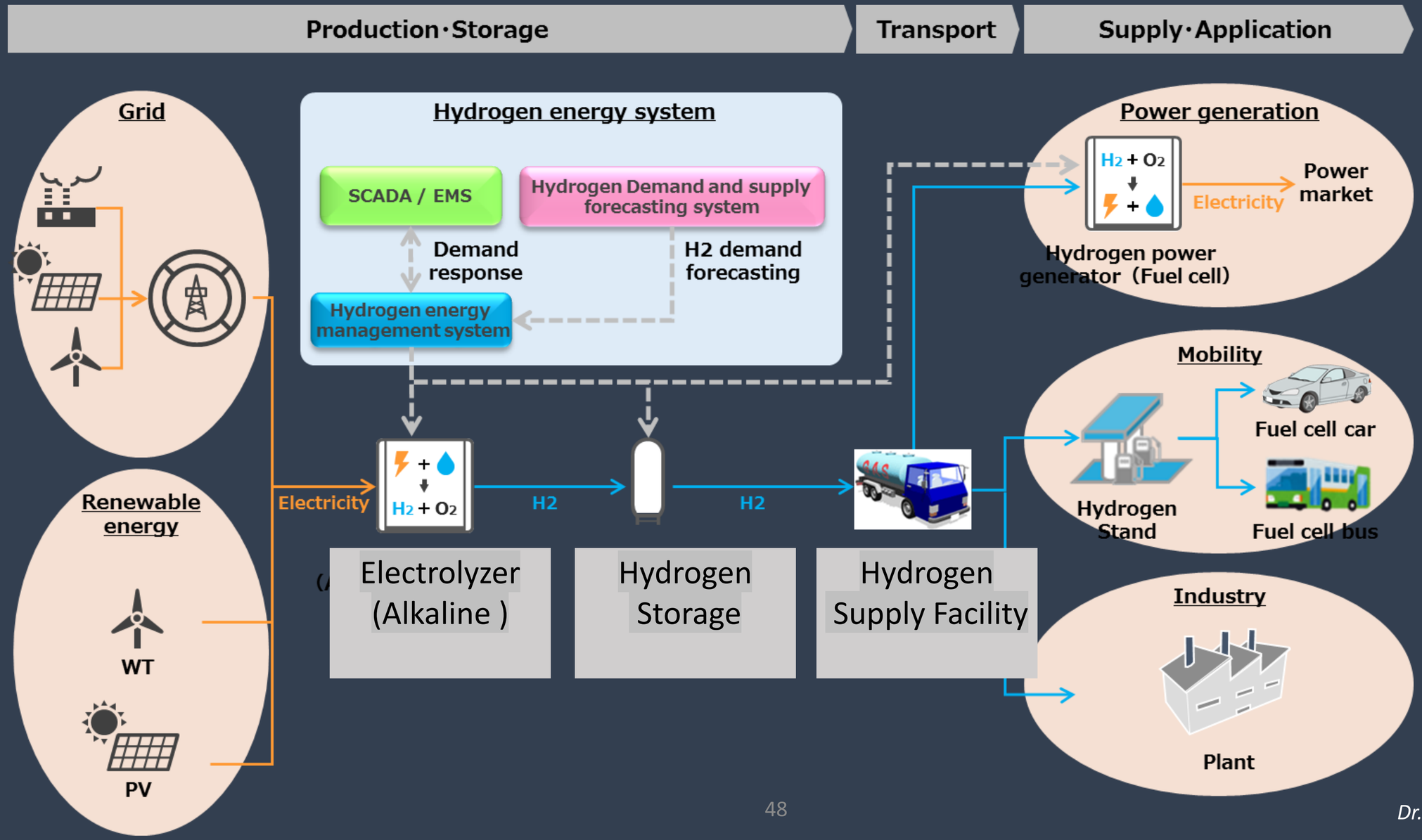
- ✓ *Include Strategic Joined Venture(s) in Operating, Engineering, Contracting & Manufacturing companies and R & D Alliance.*

Renewable & Hydrogen Production Energy System

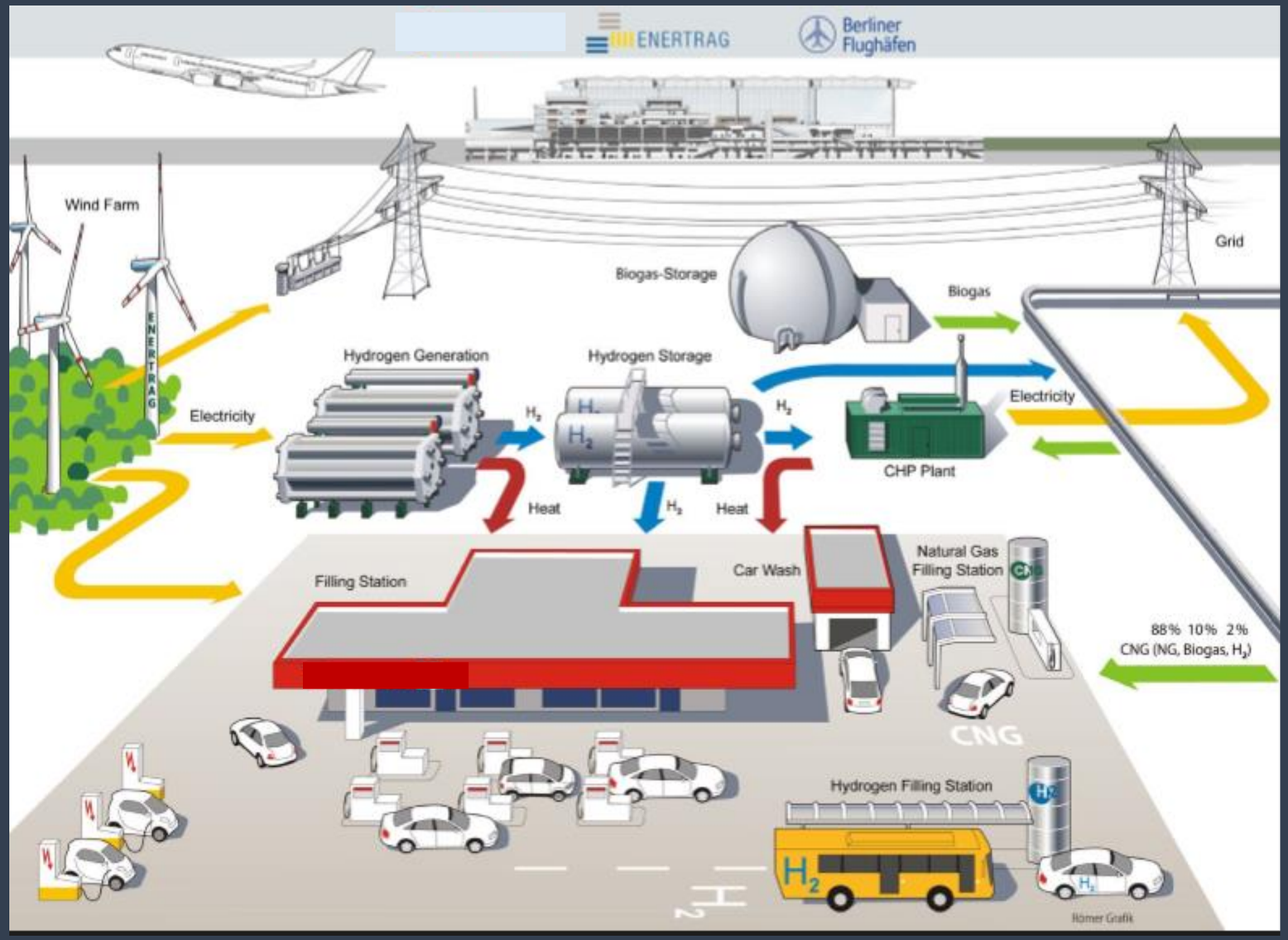


Egypt Model

Toshiba, Tohoku Electric Power and Iwatani Start Development of Large Hydrogen Energy System



Electricity Grid Stability / Renewable Energy Storage

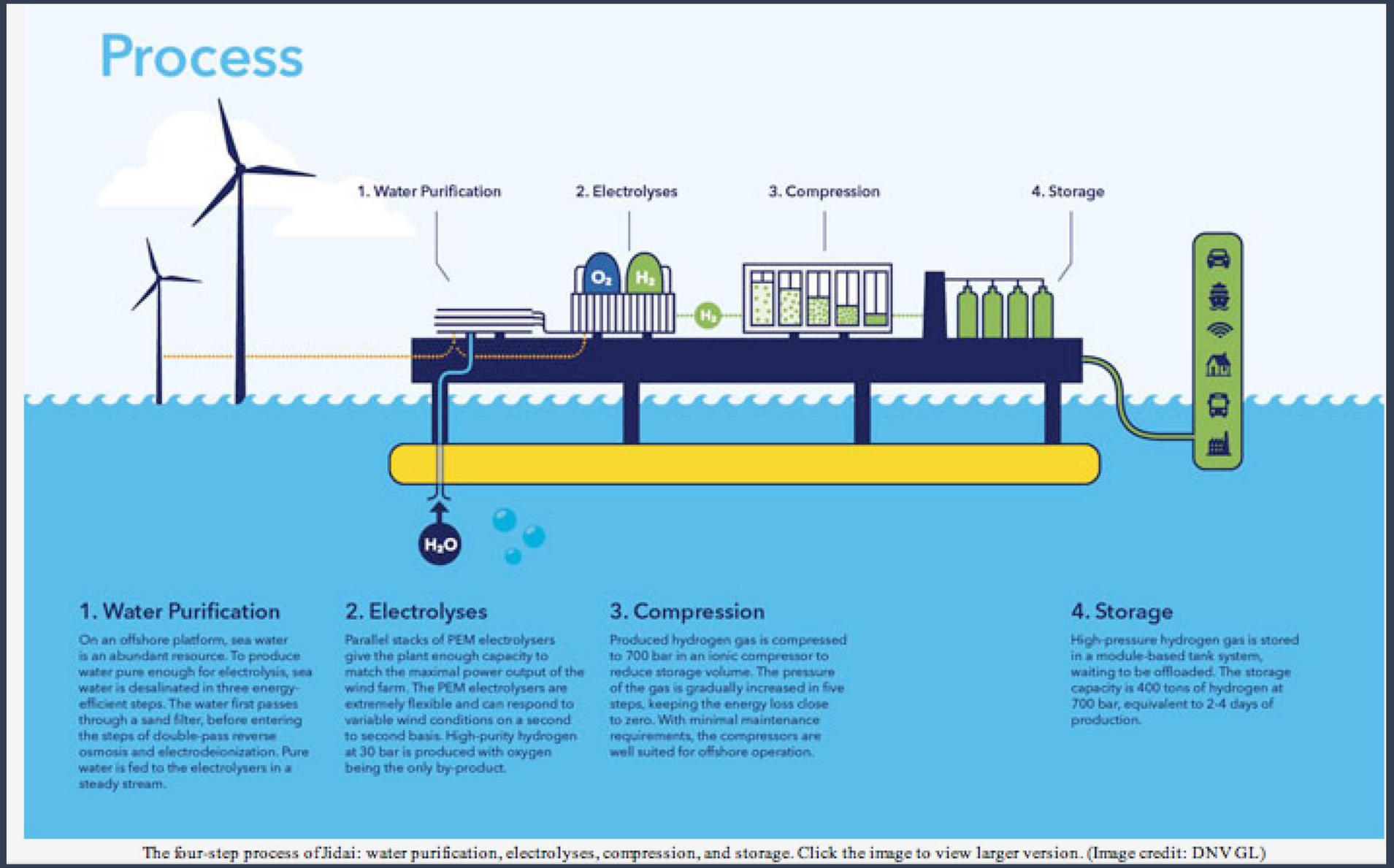


BERLIN BRANDEBURG AIRPORT PROJECT

Gas transmission pipelines offer a significantly more effective means of moving large quantities of energy over distances than power lines do and are subject to lower losses, as are distribution pipelines

Reference: FuelCellToday – May 2013

JAPAN New Era (JIDAI) Project for production hydrogen from Ocean wind & sea water



The four-step process of Jidai: water purification, electrolyses, compression, and storage. Click the image to view larger version. (Image credit: DNV GL)

Dr. Mohamed El Sawy

The Way to Face Future Challenges – Renewable Energy
Energy Think Tank Group

All of the above warrants the creation of Independent Regulatory Authority (Energy Think Tank Group) for energy – and its uses if its electricity, heat, transportation and industry , which would operate in the best interest of the Nation & the Economy. The main objective of this Authority shall be to Coordinate and Develop Energy Strategic Plan for short – medium –long (a 50-year plan) & ensure / oversees its implementation, also ;

1. *Ensure that Energy from all sources are considered & the use is optimum most impotent its sustainability for the medium and long terms.*
2. *Ensure that the Energy Strategic Plan is developed in coordination with its users if it is electricity, heat, transportation, industry.*
3. *Ensure that Ultimate technology to increase efficiency in the production and consumption of energy are continuously updated & adopted.*
4. *Ensure that Strategy projects/ initiatives developed are in line with the Strategic Plan & coordinate Quarterly updates.*