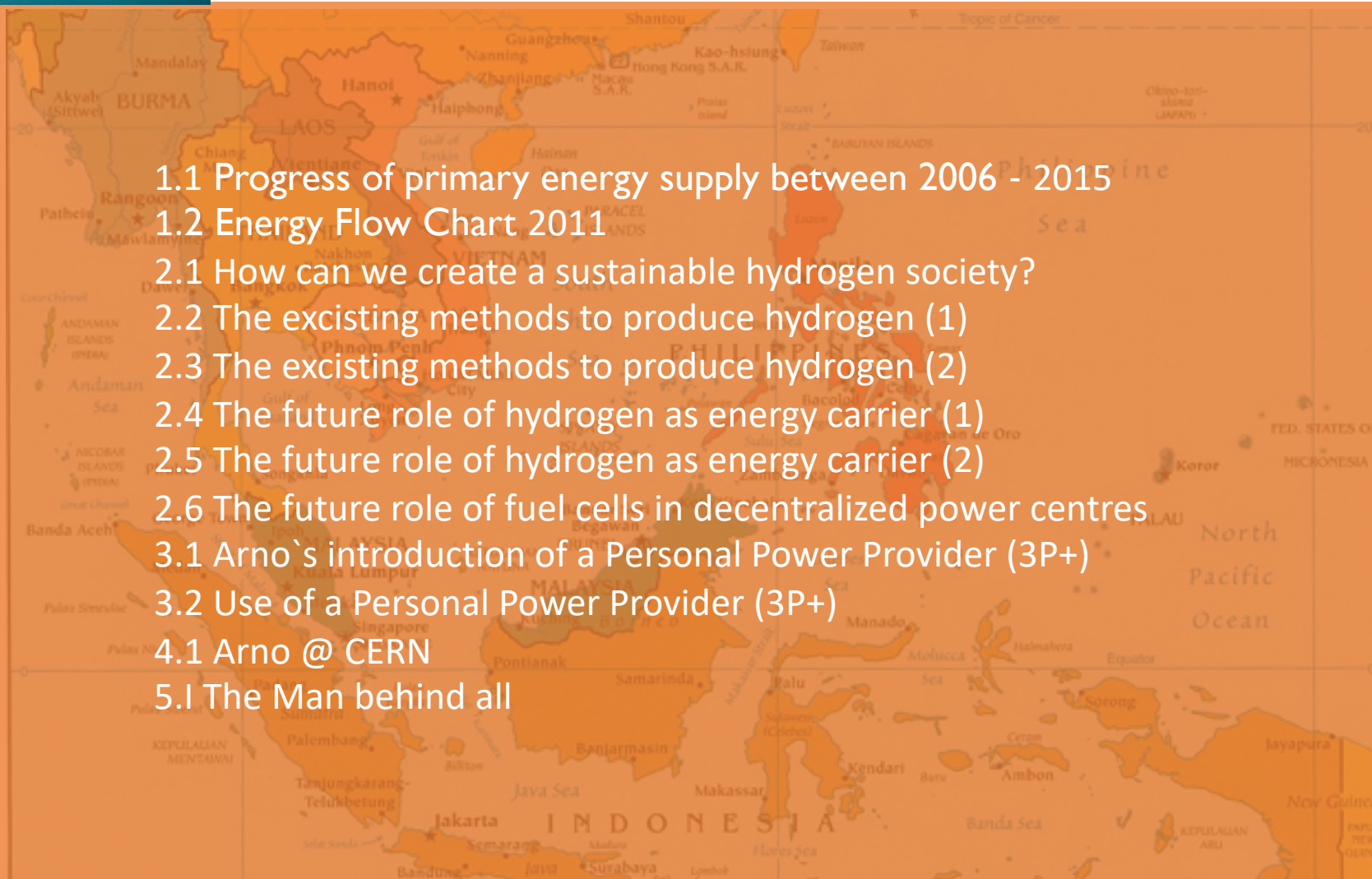


# Off the Grid Our way to a sustainable Hydrogen Society

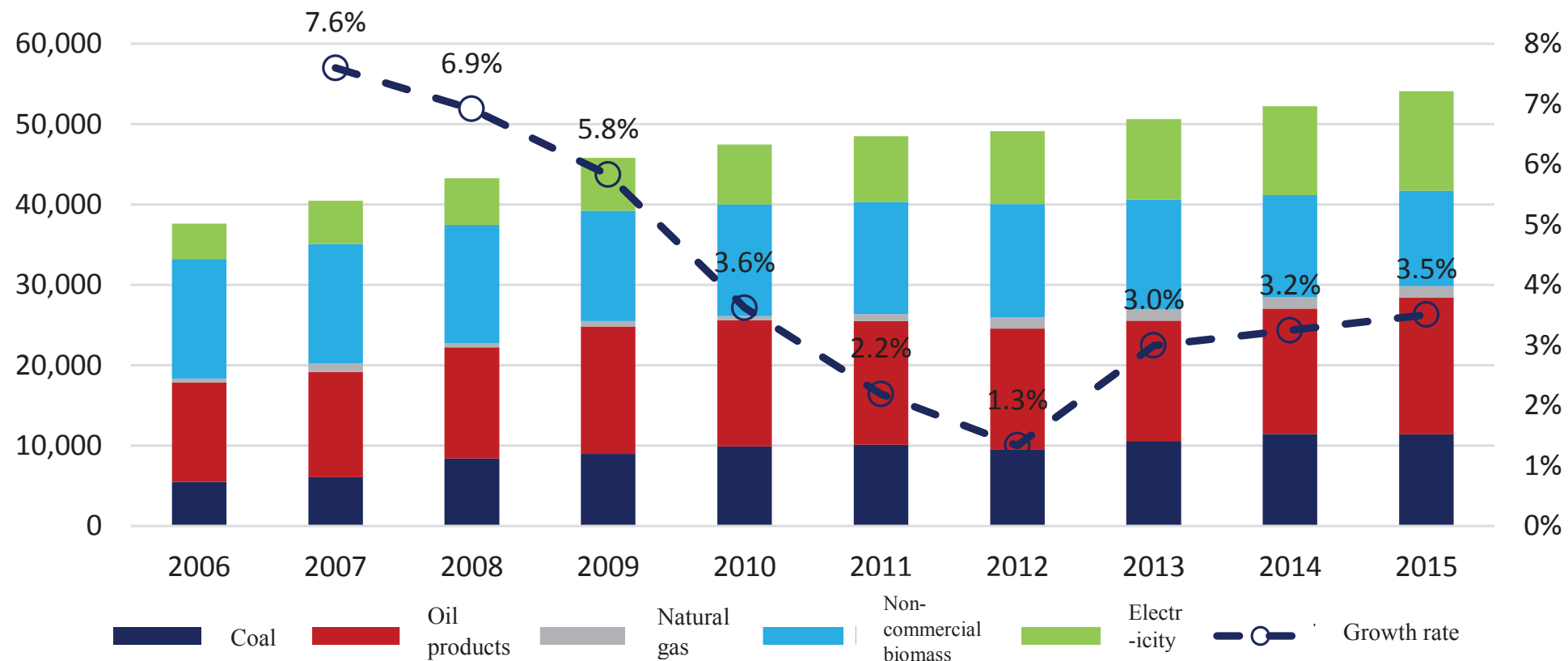
**Keynote Speaker I**  
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## 1. 1 Progress of primary energy supply between 2006 - 2015 in Vietnam



Source: Vietnam Energy Outlook Report 2017, Danish Energy Agency



### 1. 1.1 Progress of primary energy supply between 2006 - 2015

As estimated, the non-commercial biomass energy has gradually been replaced by other commercial energy sources.

The shift to fossil energy has been a key reason for the increase in greenhouse gas (GHG) emissions.

In the past decade, Vietnam has had the highest GHG emissions in the ASEAN region.

The total GHG emissions per capita have increased nearly 3 times in a 10 year period, while the carbon intensity per GDP increased by 48%.

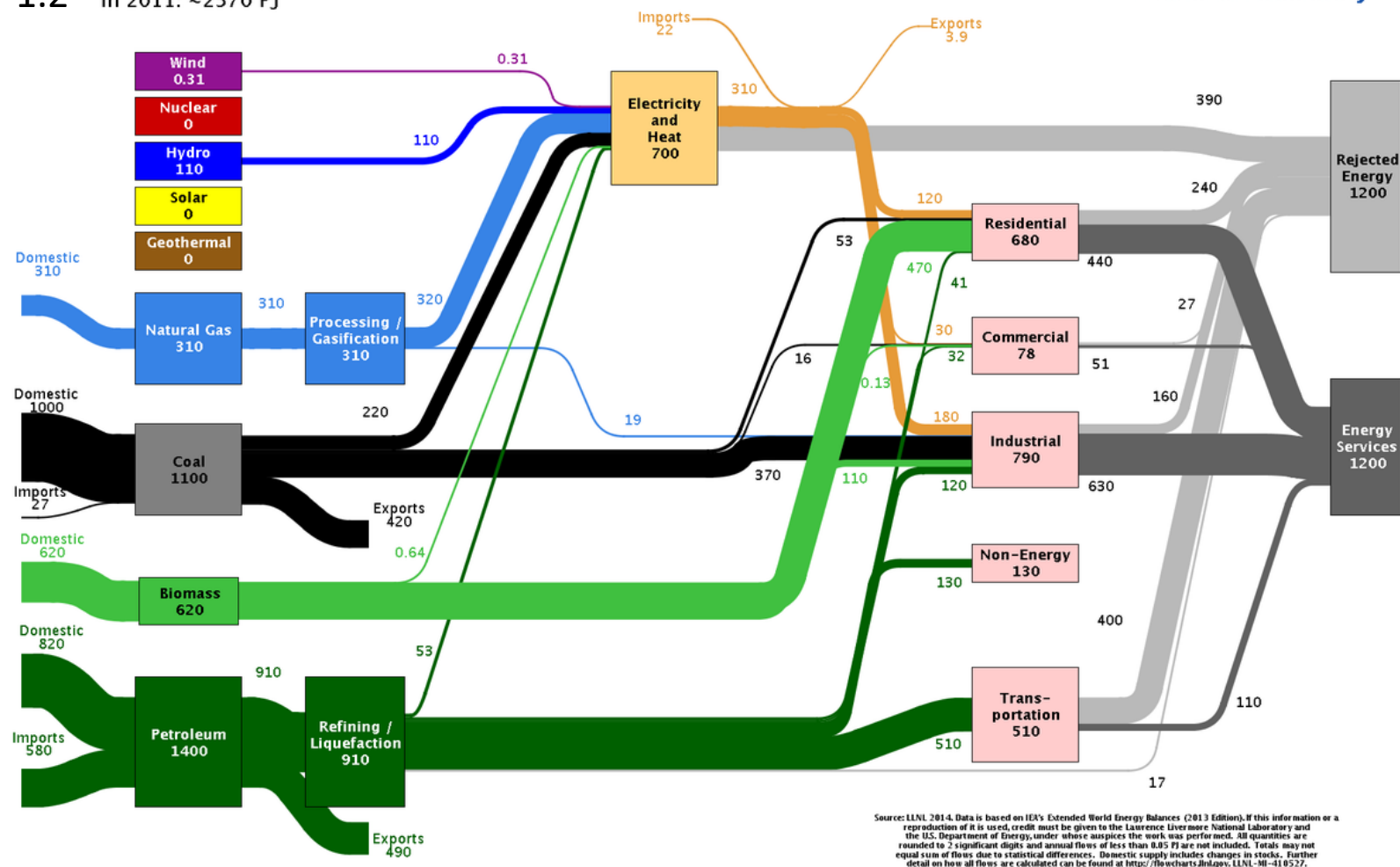
Crude oil, coal, gas, hydro power and non-commercial energy are the energy sources exploited within the country. The total exploited energy in recent years intends to remain stable, mainly due to no large fluctuation in the exploitation volume of commercial energy products.

Source: Vietnam Energy Outlook Report 2017, Danish Energy Agency



## 1.2 Vietnam Energy Flow in 2011: ~2570 PJ

Lawrence Livermore  
National Laboratory



Source: LLNL 2014. Data is based on IEA's Extended World Energy Balances (2013 Edition). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the U.S. Department of Energy, under whose auspices the work was performed. All quantities are rounded to 2 significant digits and annual flows of less than 0.05 PJ are not included. Totals may not equal sum of flows due to statistical differences. Domestic supply includes changes in stocks. Further detail on how all flows are calculated can be found at <https://flowcharts.llnl.gov/>. LLNL-MI-410527.

### 1.2.1 Arno's thoughts on the past energy situation in Vietnam

According to the Lawrence Livermore National Laboratory, in Vietnam in 2011  
(Sorry, these are the last available numbers from LLNL)  
used approx. 2.570 Peta Joule (PJ) of which: 607 PJ were imported from other countries.  
And 490 PJ were exported to other countries.

In total just 1.200 PJ could really be used.  
For Residential use (440 PJ); Commercial (51 PJ); Industrial (630 PJ);  
Non-Energy (130 PJ); and Transportation (110 PJ).  
The remaining rest, which accumulates to also 1.200 PJ (= 50 %) were lost inside the system  
in conversion and distribution.

However, they were paid by all consumers.

2.1

## > How can we create the sustainable hydrogen society?

### *Hydrogen Vision:*

- 1) Hydrogen has to become a common commodity
- 2) Hydrogen has to be produced free of pollution and losses
- 3) Hydrogen has to be traded locally, based on supply and demand
- 4) Hydrogen has to be used for electrification, transportation and convenience

### *Fuel Cells Vision:*

Fuel Cells have to utilize their advantages in connecting the markets for:

→ 1. **Electricity** → 2. **Heat** → 3. **(clean) water**

**Fuel Cells have to be used as decentralised, personal power systems**



### 2.1.1 How can we create a sustainable hydrogen society?

In order to create a sustainable hydrogen society, hydrogen has to become a common commodity, must be produced free of pollution and losses, has to be traded global, based on supply and demand and must be used for electrification, transportation and convenience.

Fuel cells produce electricity not by combustion but by chemistry.

Their advantages have to be utilized in connecting the markets for electricity, heat and (clean) water.

2.2

## > The existing methods to produce hydrogen (1) (Conventional)

Hydrogen is the most abundant element in the universe, most of it occurs in chemical combination with oxygen in water, so it has to be produced:

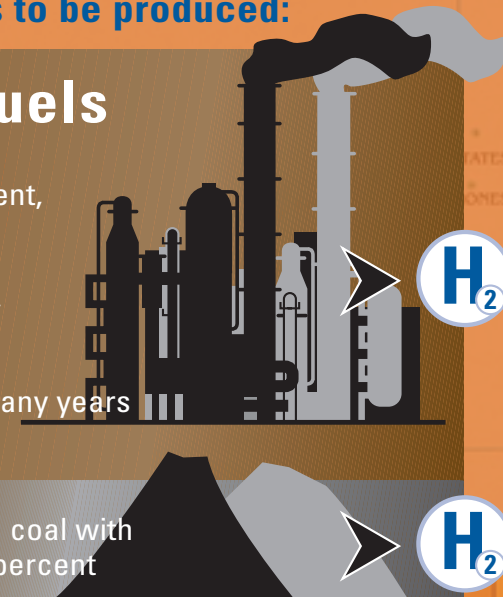
### 1. Hydrogen production from fossil fuels

**1.1. Steam reforming of natural gas** at this time the most efficient, economical and widely used process for hydrogen production

**1.2. Partial oxidation** converts hydrocarbons heavier than naphtha, using natural gas, ethanol or even gasoline as feedstock

**1.3. Thermal cracking of natural gas** has been practised for many years using a methane-air flame in tandem furnaces or fixed bed reactors

**1.4. Coal gasification** (Koppers-Totzek process) oxidizes pulverized coal with oxygen and steam, to produce hydrogen with purity higher than 97.5 percent



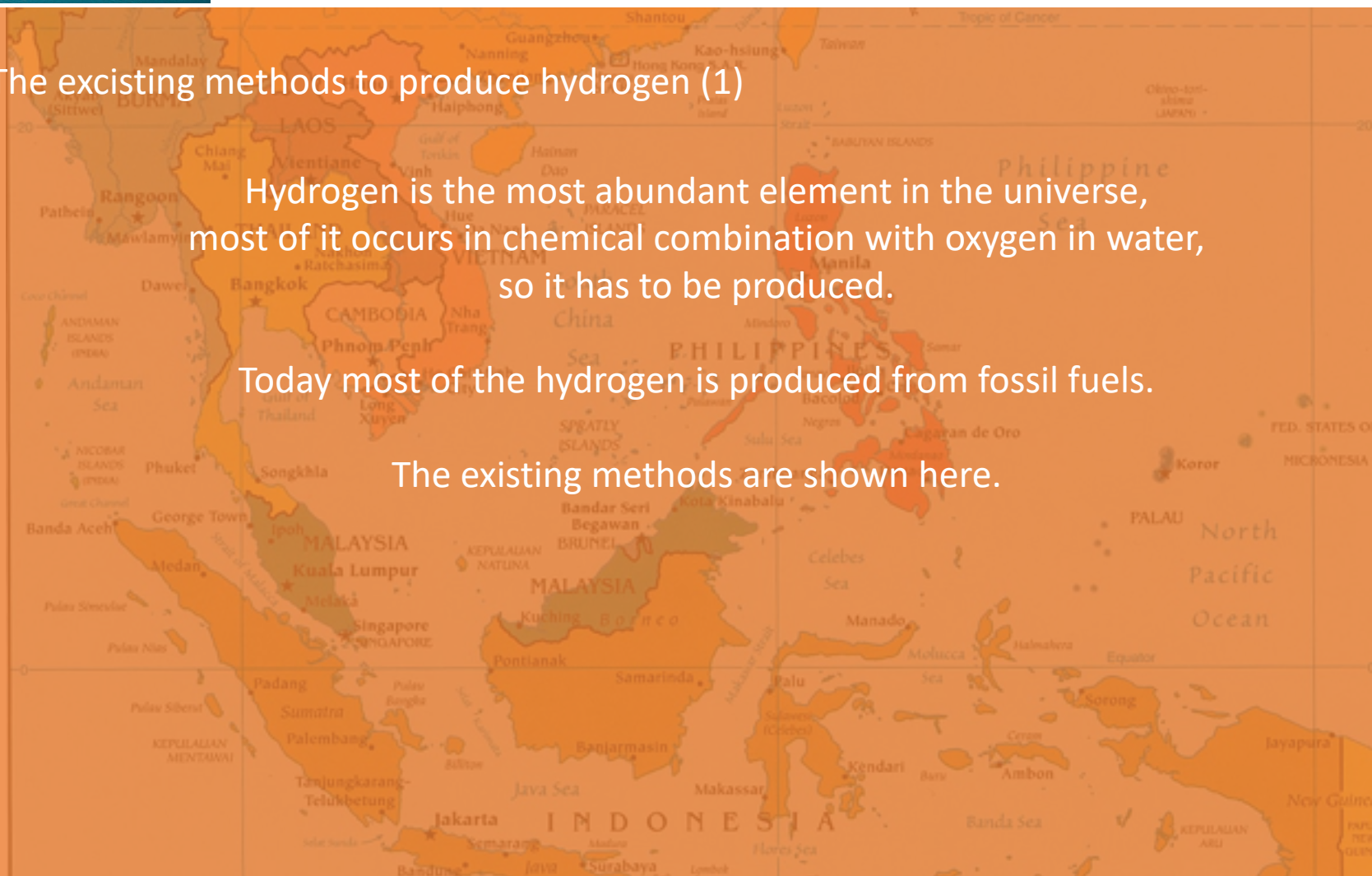


## 2.2 The existing methods to produce hydrogen (1)

Hydrogen is the most abundant element in the universe, most of it occurs in chemical combination with oxygen in water, so it has to be produced.

Today most of the hydrogen is produced from fossil fuels.

The existing methods are shown here.





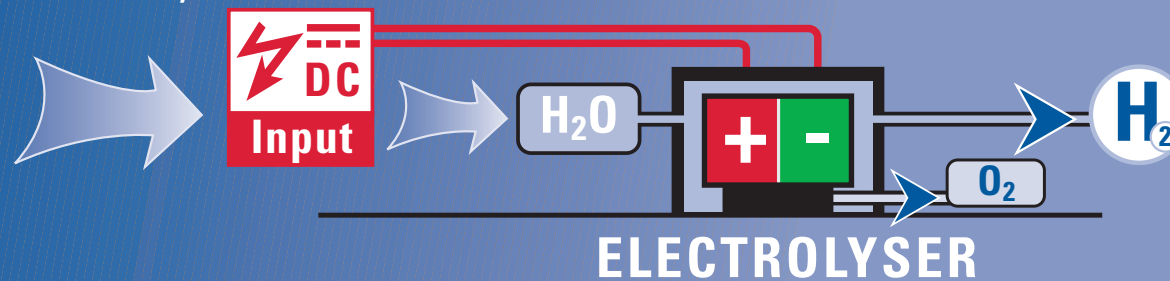
2.3

## > The existing methods to produce hydrogen (2) (Conventional)

Hydrogen is the most abundant element in the universe, most of it occurs in chemical combination with oxygen in water, so it has to be produced:

### 2. Hydrogen production with electrolyser

**Electrolysis** seems still to be the best method used for large-scale hydrogen production in a post-fossil-fuel era, however has very bad efficiency



### 2.3.1 The existing methods to produce hydrogen (2)

Another method is the hydrogen production from water through electrolysis.

This is done in 1% to 5% of all global hydrogen production with a rather bad efficiency.

The "cleanliness" of such hydrogen depends on the cleanliness of the electricity in the grid.

And on the distance of the point of production to the point(s) of usage.

The more coal, nuclear and /or gas power plants supply the grid, the more dirtier that hydrogen will be.

Even so called "Renewable Energies" do not really help, as the structure of the grid is ancient and not intended for that.

2.4

## > The future role of hydrogen as energy carrier (1)

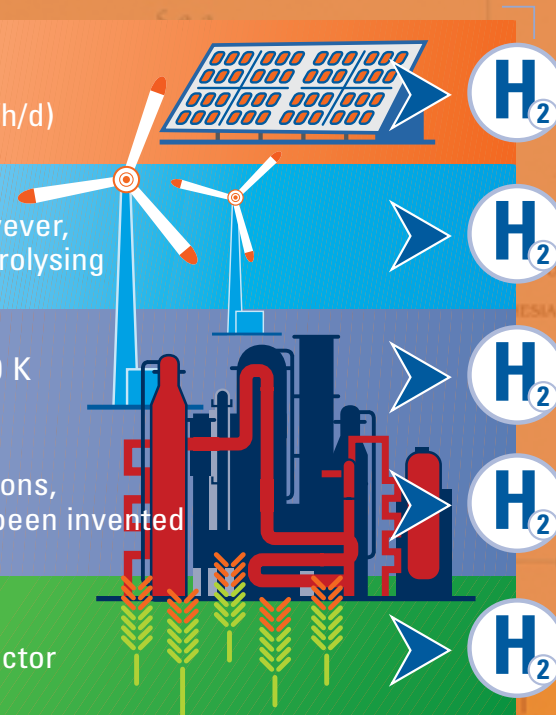
1. **Photo Voltaic** has the highest potential with solar insolation of up to 6,5 kWh per square meter per day (Avg. in the U.S. 3,0 kWh/d)

2. **Wind Power** can already produce electricity up to 6 MW, however, the electricity generated is imminent and not very suitable for electrolysing

3.1 **Thermolysis** splits water thermally at temperatures up to 3000 K raising problems with the material resistance to high temperatures

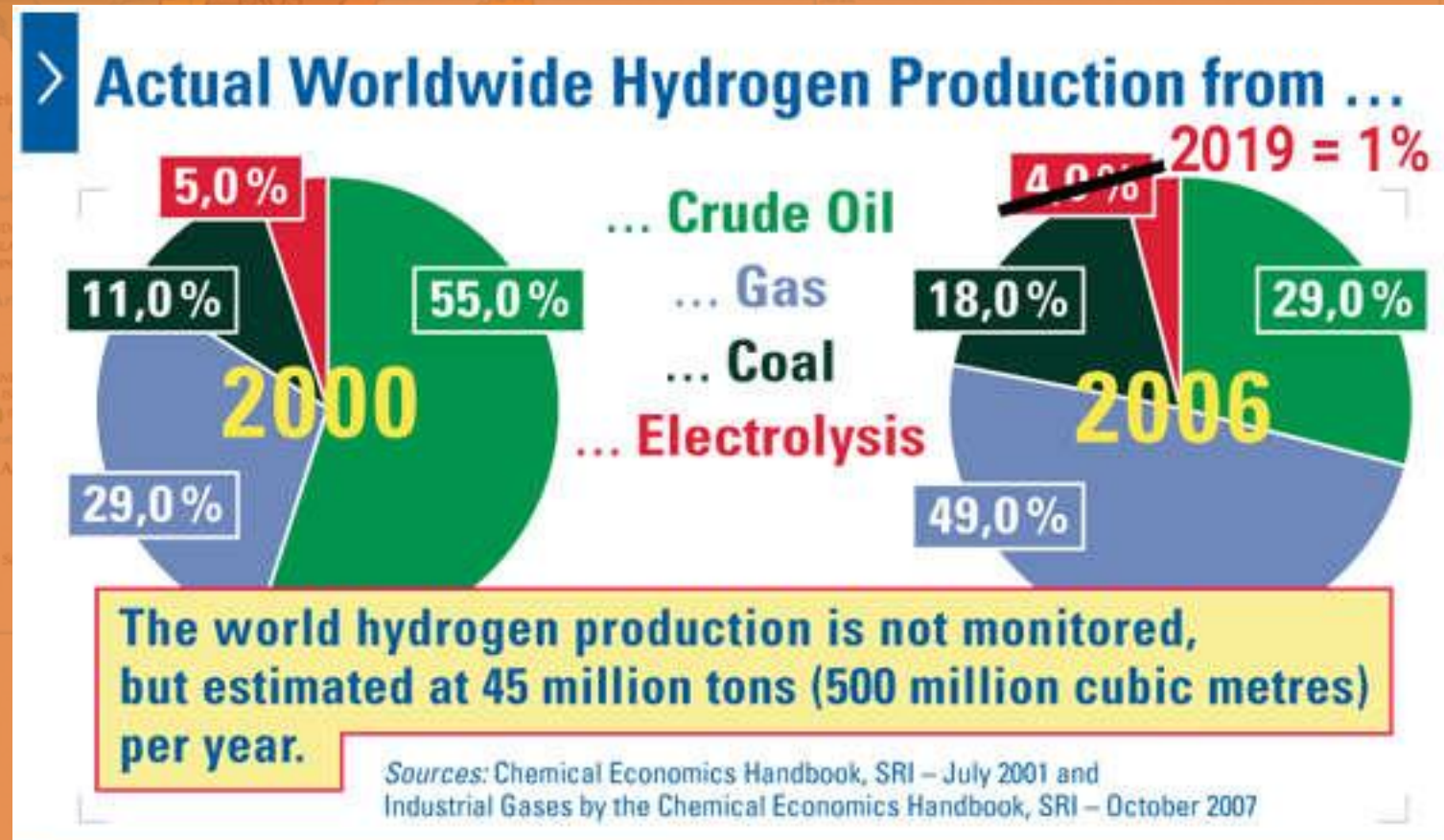
3.2 **Thermochemical** produces hydrogen through cyclical reactions, on trial since the mid-1960, with thousands of cycles which have been invented

4. **Biomass** can produce hydrogen by a pyrolysis/gasification process, heating the biomass/water slurry under pressure in a reactor





### 2.4.1 The future role of hydrogen as energy carrier (1)



#### 2.4.1 The future role of hydrogen as energy carrier (1)

At present no hydrogen is actually being used by the end consumer.

The design target for hydrogen production must be to use neither fossil fuels nor electrolysis but all existing renewable energies directly, to illiminate losses and to broaden the sources.

All these processes have to be developed and complemented with novel methods.

Down-scaled to be used in decentralised mass-markets, the user of the power will become its producer!

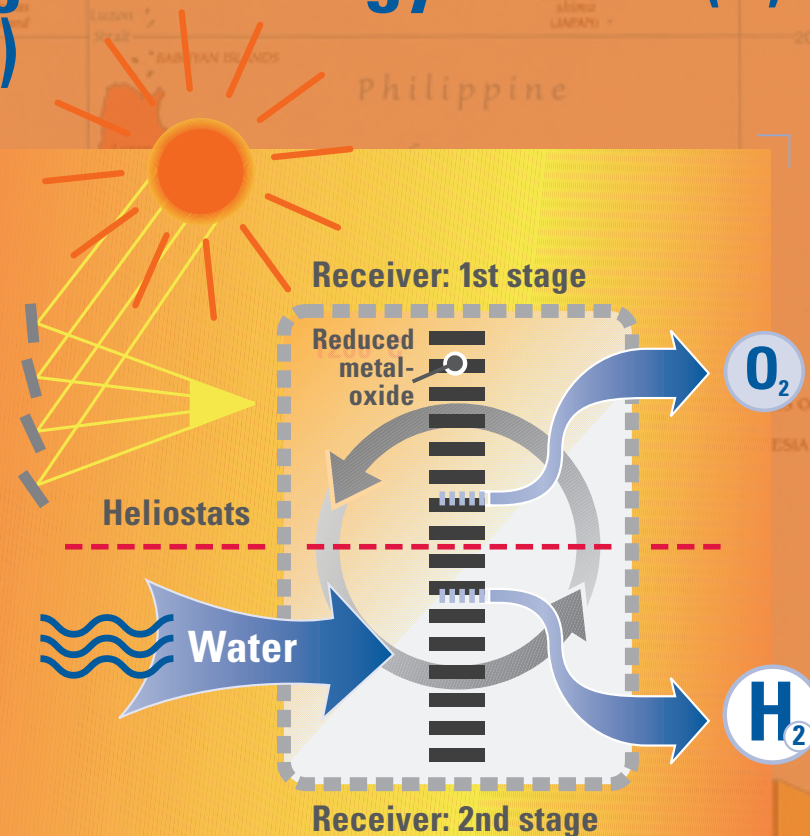


2.5

## > The future role of hydrogen as energy carrier (2) (direct solar production)

**5. Photolysis** direct extraction of hydrogen from water. Uses only sunlight in photobiological, photochemical or photo-electro-chemical conversions

**All processes have to be developed and complemented with novel methods. Down-scaled to be used in decentralised mass-markets, the user of hydrogen and electricity will become their producer!**



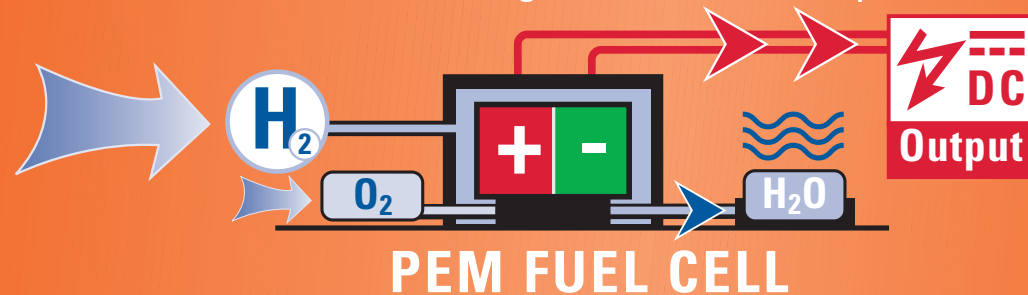


2.6

## > The future roles of fuel cells in decentralised power centers

Fuel Cells have the ability to work for three tasks:

1. **Electricity** will be utilized in buildings like hospitals, offices and houses as DC (Direct Current), as nearly all home and office appliances require DC
2. **Heat** is not being wasted or flared, but captured in the process and used for heating (in winter) or cooling (during summer)
3. **(clean) Water** is produced while making electricity and used in/externally or sold on the local market at the highest achievable price



### 2.6.1 The future role of fuel cells in decentralized power centres

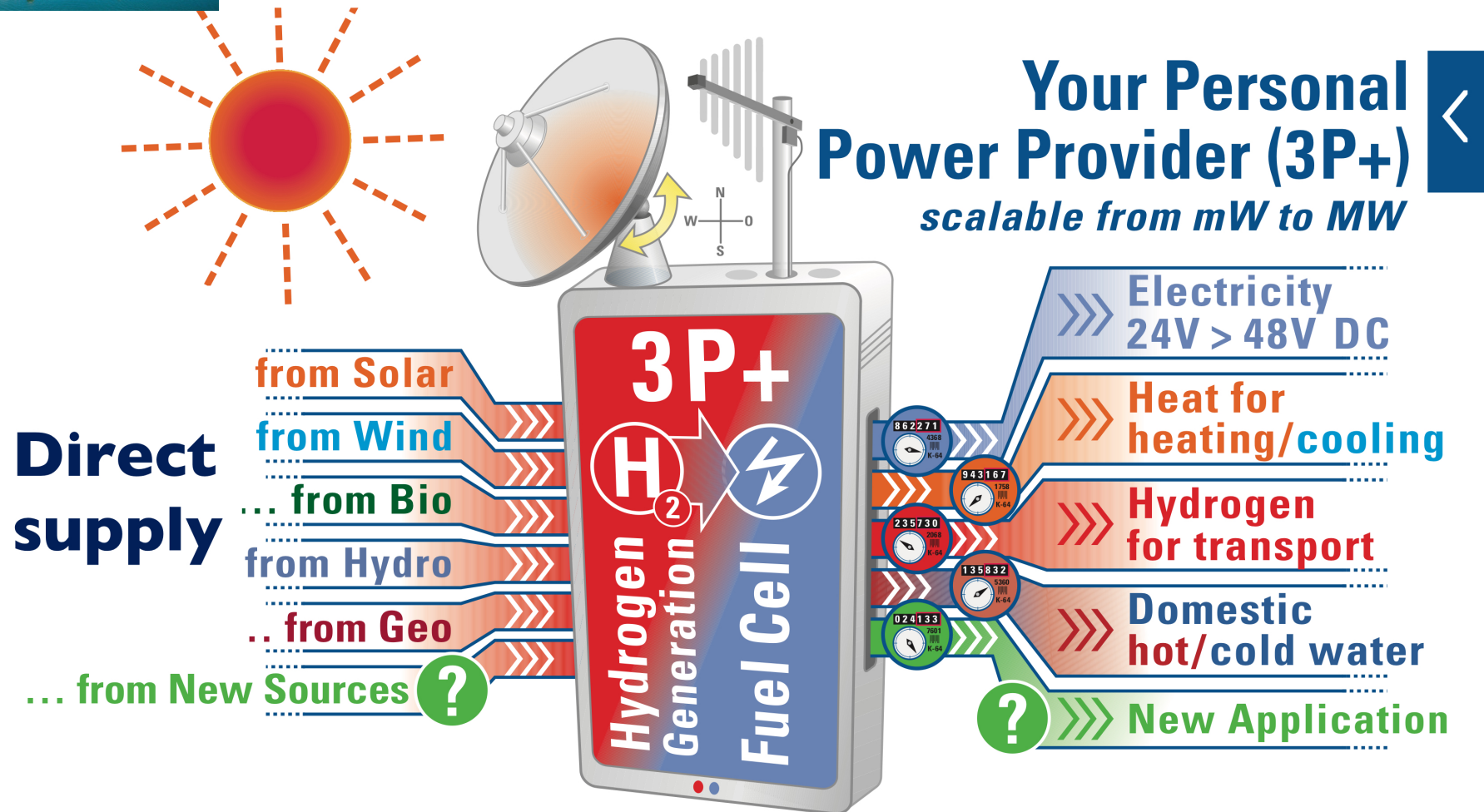
Fuel cells produce electricity not by combustion but by chemistry.

Their advantages have to be utilized in connecting the markets for electricity, heat and (clean) water.

Fuel Cells have to be used as decentralised, personal power systems in order to be implemented into the daily life.

The overall efficiency of such decentralised power centers is by far better than any of today's existing energy systems!

3.1



All Renewable Energies **Input** >>> **Output** All personal power demands



### 3.1.1 Arno's introduction of a Personal Power Provider (3P+)

Imagine the day when there are no power (electricity) bills anymore. Neither any bills for heating, cooling, and transport. That day has to come. The sooner, the better.

Today's production of electricity, as well as hydrogen, its distribution, storage and utilization are globally dependent upon conventional technologies from two centuries ago, which were never ecological feasible in the first place. Also when producing electricity from renewable energies like wind or solar power and connect them to the grid, the overall efficiency for producing and distributing goes down rapidly.

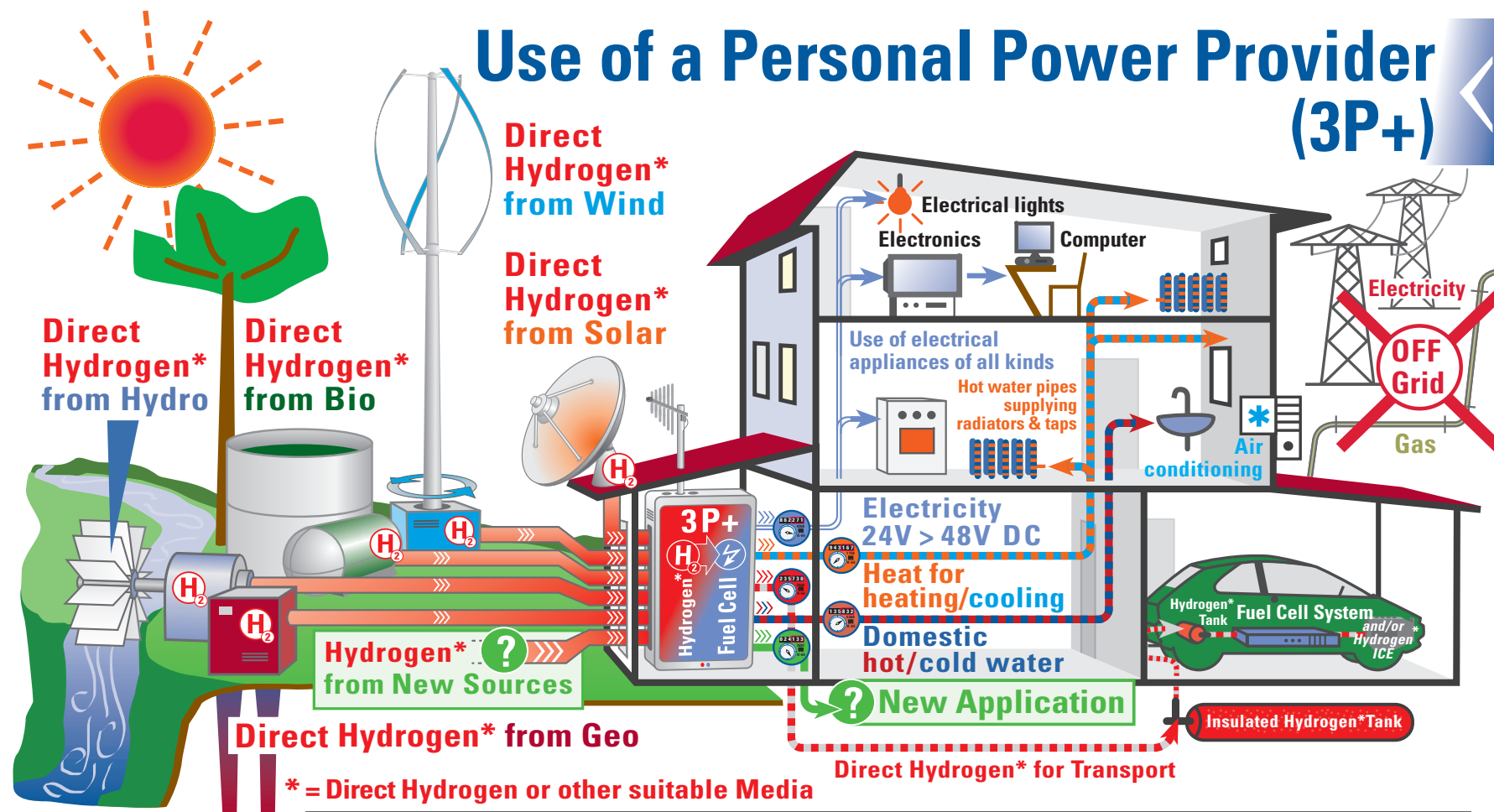
However, there are alternatives.

Globally, the ultimate target for future supply of the energy demand for mankind must be to use all existing locally renewable energies directly on-site with only one conversion step.

A combination of new photo-biological and photo-electrochemical processes has to be developed and combined with the implementation of a new system called Personal Power Provider (3P+).

Scalable from mW to MW, the Personal Power Providers (3P+) can be used as collection and storage devices for ALL power needs including heating/cooling, a media for transportation and domestic hot and cold water.

3.1



All Renewable Energies **Input** >>> **Output** All Personal Power Demands



### 3.2.1 Use of Personal Power Providers (3P+)

The sun is actually providing much more than enough energy to supply all needs of mankind. However, it is not shining 24/7 even here in the ASEAN countries. Nor does the wind blow 24/7.

If we want to fulfill the needs of power to the people, we have to use – in addition to photovoltaic (PV) - ALL locally available renewables like geothermal, running water and also solar-thermal.

When using them smart and individually, different for each local site, the needs for storage will become much smaller as with former, conventional solutions.

All personal power demands, which are needed today for electricity, transportation, cooking, heat and hot and cold water can easily be pleased simultaneously.

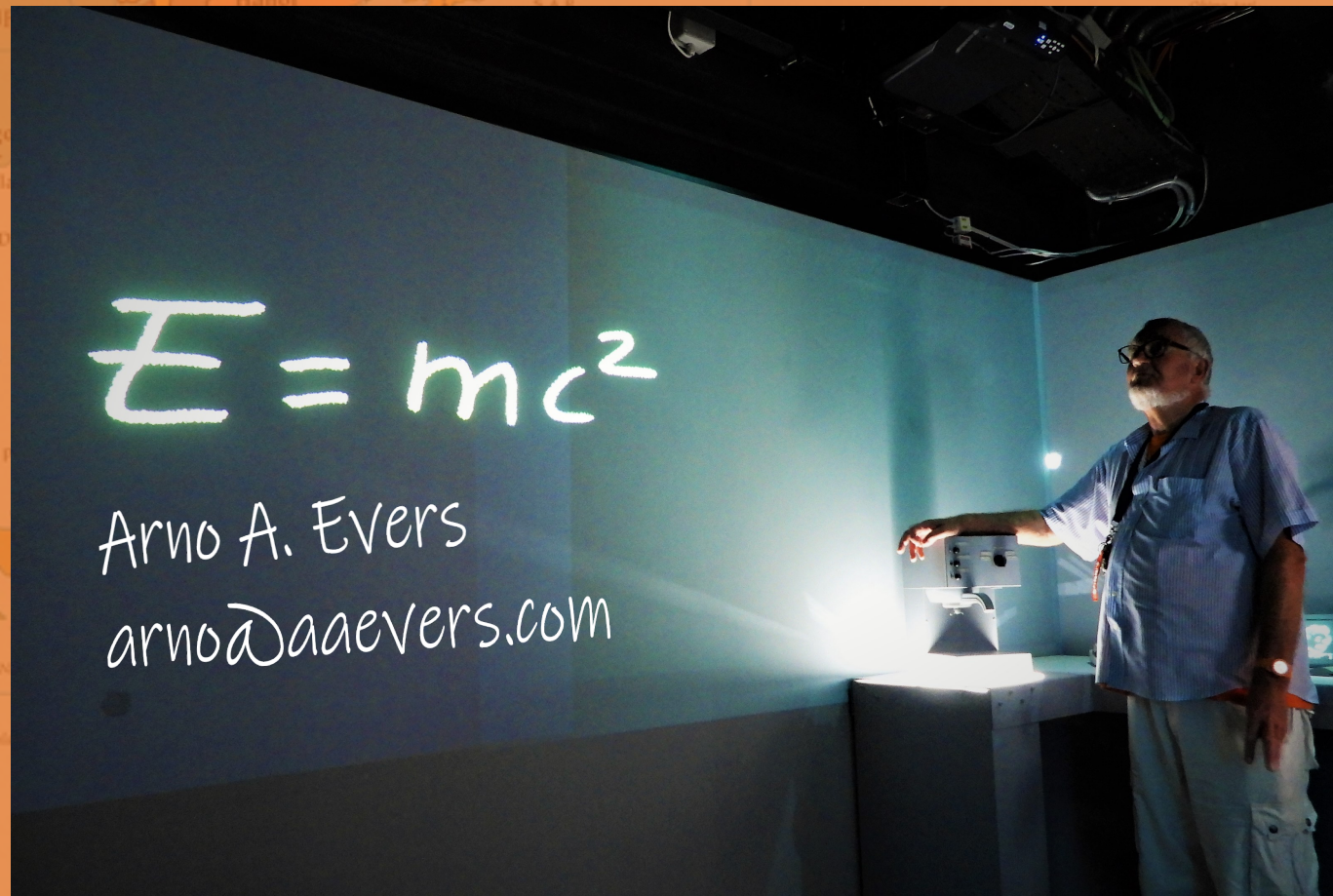
And can with the Use of Personal Power Providers (3P+) be done without being dependent on ANY grids.

Using low voltage DC Power supply inside the houses and offices.



4.  $e = mc^2$

Arno@CERN



IMPLEMENTING NEW IDEAS TO SUPPORT OUR ENERGY FUTURE

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## 5. Arno A. Evers – The Man behind all

- 1968 DECCA Radar and Navigator Service - Engineer in the Middle East, based in Doha, Qatar
  - 1985 Deputy press spokesman for Messerschmitt-Boelkow-Blohm GmbH in Hamburg and Munich
  - 1990 Foundation of Arno A. Evers FAIR-PR in Munich, Germany  
Group Exhibits for the German Space and Aircraft Industry
  - 1995 Founder of the annual Group Exhibit Hydrogen + Fuel Cells at Hannover Fair incl. Full Service Package  
now the biggest and most international of its kind worldwide
  - 2004 Conference and exhibition:  
Renewable Energies China incl. Hydrogen + Fuel Cells for the Chinese Ministry of Science and Technology  
(MOST) in Shanghai, PR China
  - 2006 Sale of Group Exhibit Hydrogen + Fuel Cells to Deutsche Messe AG
  - 2010 Publication of the book “The Hydrogen Society More - Than Just a Vision?”
- since 2003 Participation at 110+ international conferences on energy related topics as speaker, presenter and/or visitor



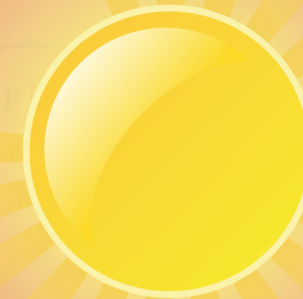


**The future of our global energy situation  
can only be solved  
when the same mistakes are not made again!**

**Let you be the first to start now.**



# Thank you!



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