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A Hydrogen Outlook from a Transition Economy: Development of Hydrogen Fuel Cells by H_2 ECOnomy in Armenia

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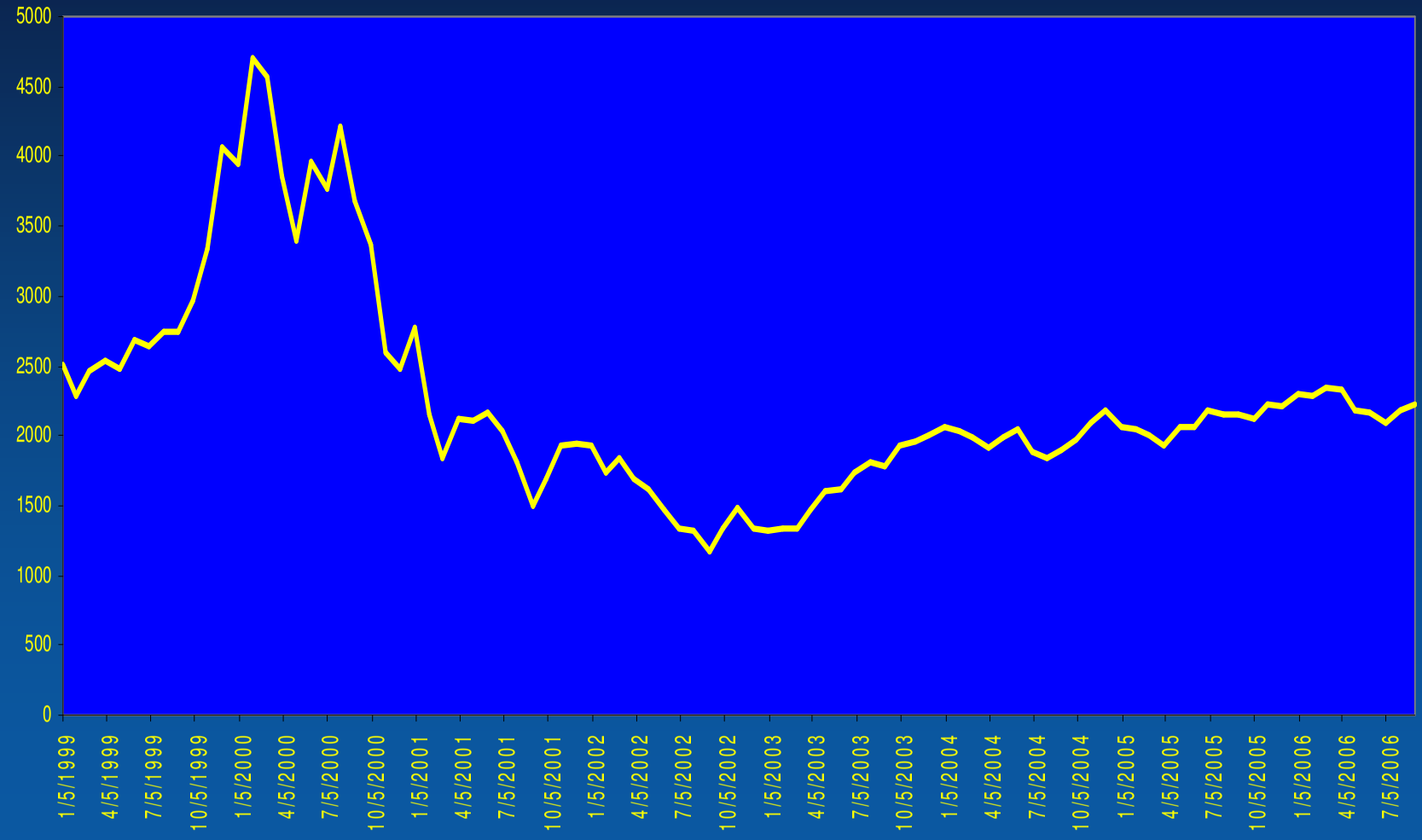
Hydrogen Economy and Fuel cells – the past and the present

- Since 1990s forecasts talking about the numbers of fuel cell cars, residential units, etc. to be around by 200X
- Yesterday's expectations don't match today's reality
  - **Why?**

Let's go back to history…

NASDAQ Composite

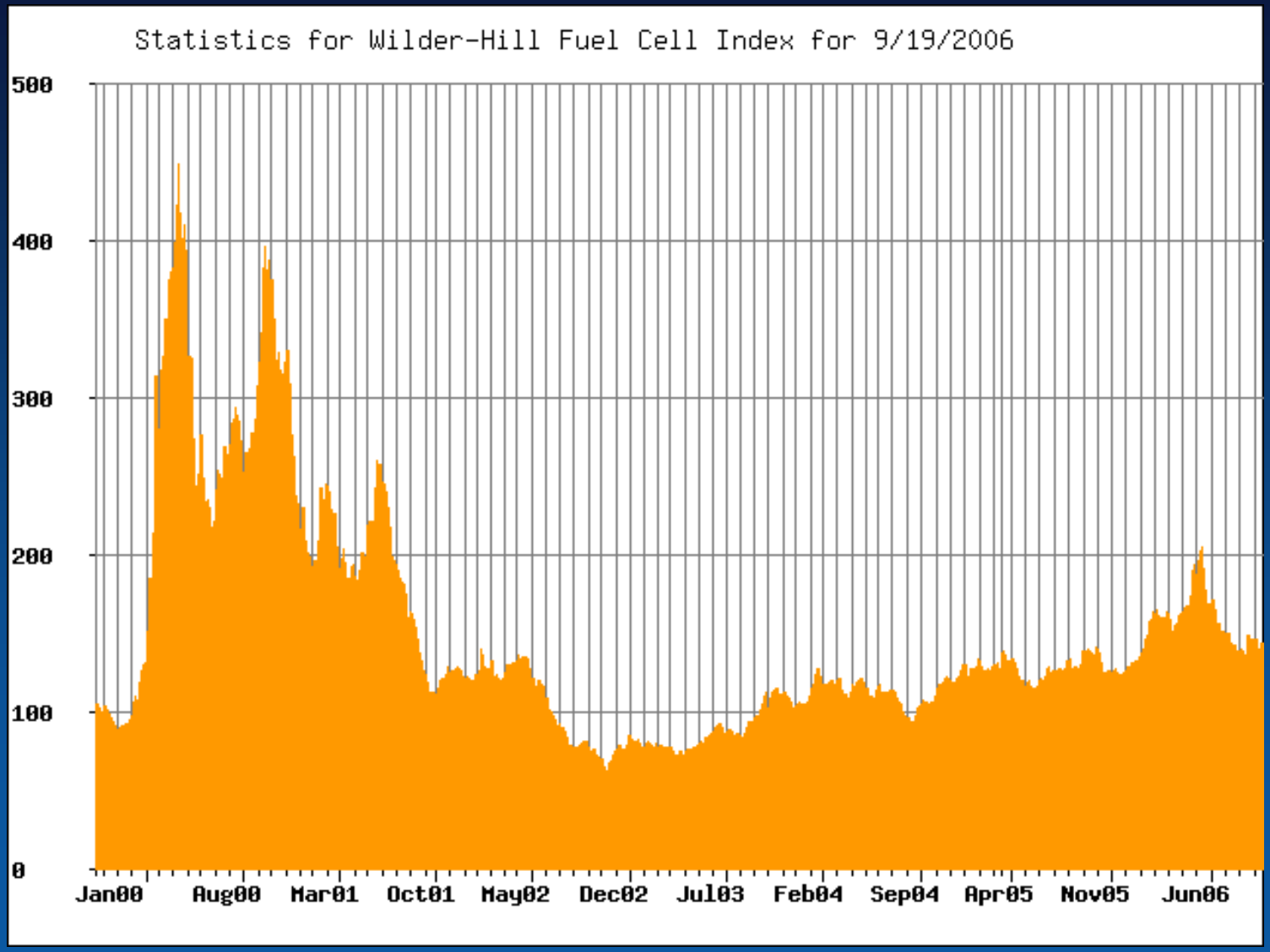


Downturn

- 2001- downturn of the stock market, especially tech companies
- 9/11 consequences
- Economic growth slowdown, job cuts.
- Oil prices today – around $60-70 a barrel

Fuel cell investors disappointed – why?

Fuel cell stocks



In the fuel cell industry

- No major technology breakthrough
- Expensive fuel cells ~ US$2000 or more per kW
- Lack of hydrogen infrastructure
- Costly hydrogen production and storage
- High cost of technology development – consequently, high capital burn rate.
- The cost of fuel cells doesn't go down fast enough.

Oil Economy

- Current Oil Economy
  - Oil consumption rises in almost geometrical progression
  - Situation in oil-rich Middle East
  - Modernization coupled with energy consumption growth in the third world
  - And so on and on...

All of this results (and will continue to result) in skyrocketing oil price.

Solution

Hydrogen Economy!!!

(despite the challenges)

The Main Challenges to Hydrogen Economy

- High cost of fuel cells
- Underdeveloped hydrogen infrastructure

The main driver for hydrogen economy is going to be the cost.

Market Feedback

- Early adopters right now ready to pay premium to have fuel cell powered energy independent homes and offices (or at least long-term backup power).
- Industry too – uninterrupted power for critical applications, remote sites, etc.

However, with current prices, even they cannot afford…

Q. How to bring the cost down?

A. Outsourcing the R&D

Let's go back to history again…

- Late 1980- early 1990s: manufacturing moving to low cost locations – Taiwan, China, Malaysia, Indonesia, etc.
- Made possible because of:
  - Development of IC technologies,
  - Shrinking transportation costs,
  - Easing trade barriers

Result: better living standards for everyone, global competition pushes the prices down, but forcing to maintain the same or better quality

The same can happen in the hydrogen and fuel cell industry!

R&D Outsourcing Realities

- Generating IP in the developed countries getting more expensive.
- Outsourced R&D getting more momentum throughout the world.
- There are concerns about IP protection, but there are ways to address those.

Where to outsource?

- FSU countries still have significant potential & brainpower, (thanks to the well-developed military industry in the former Soviet Union).
- Example: Armenia
  - "Silicon Valley of the Soviet Union"
  - Scientists & engineers: physics, chemistry, electronics, IT, etc.
  - Used to be one of the Soviet R&D hubs for military and other industries.
  - Low costs (a top-notch Ph.D. costs ~$6000-10000 a year!)
  - Traditionally inclined to education and research (one of the highest literacy and per capita higher education rates in the world).

FSU Challenges

- Scientist/researcher mindset – jolted by realities of commercial business as opposed to pure research
- The other extreme - many scientists/researchers are now in unrelated businesses to make living
- Lack of marketing and management
- English language skills

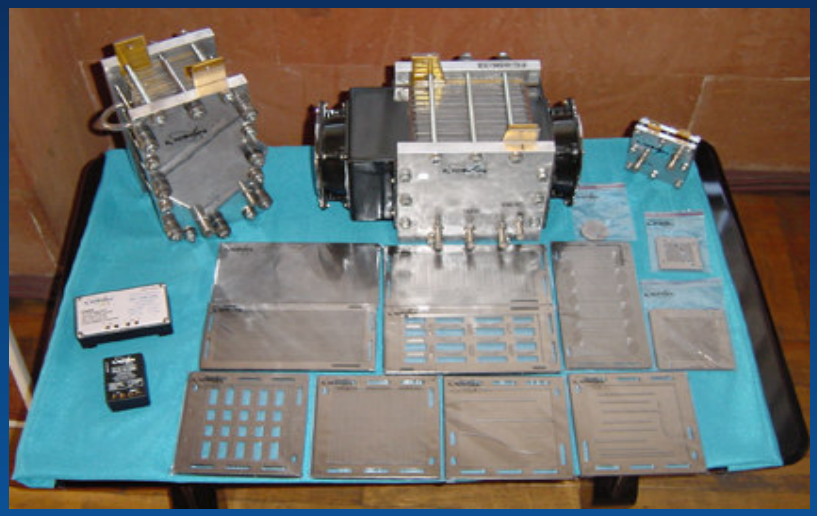
Challenges can be addressed!

- Several US-government sponsored programs directed to scientific potential retention and use in peaceful purposes.
- US Department of State funds student exchange programs to provide Western education, business skills to people from FSU.

H_2 ECOnomy' example as a model

- Est. 2000 as a FC group, incorporated in 2002
- Investment from the USA
- Local scientific brainpower skilled in fuel cell-related disciplines.
- As of now – 30 employees, (mostly scientists and engineers), 5 labs plus engineering.
- Involving young generation
- Western educated managers

H_2 ECOnomy to Date



- Formed and put into work a capable team
- Developed a number of FC technologies
- Tested them in practice
- Generated sales (educational/demo fuel cells)

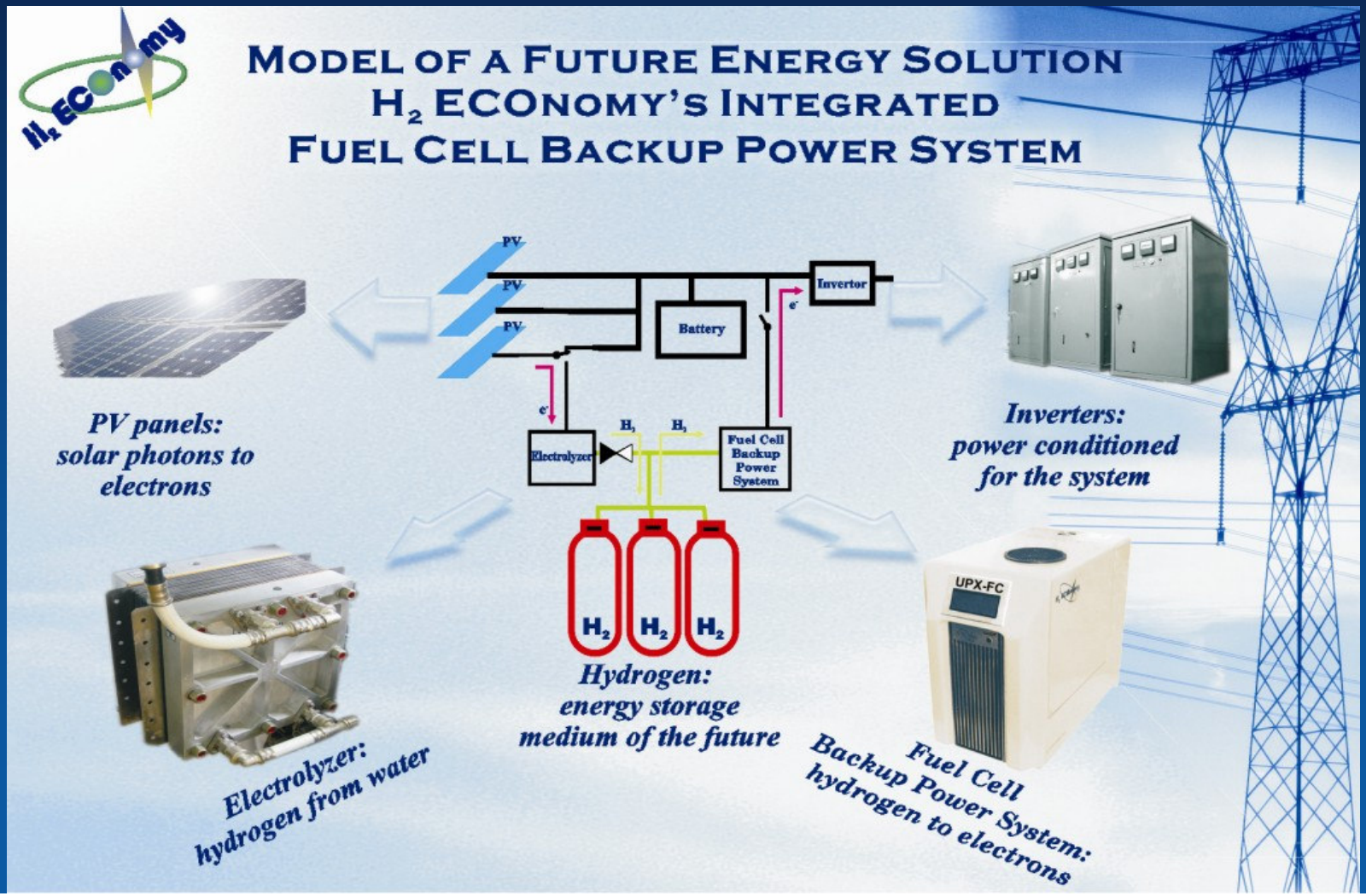
Scope of Activities

- Components – BPP, MEAs, other;
- Single cells;
- FC stacks 1W-1kW;
- FC backup power systems 0.5-1kW;
- FC test systems;
- DC-DC converters;

All of these done at H_2 ECOnomy, at a fraction of cost that it would take to do elsewhere!!!

Support from External Sources

US DoE sponsored program (Initiatives for Proliferation Prevention) to install a complete renewable hydrogen system



Why it can work?

- Low R&D costs – low burn rate.
- Investor/partner risk mitigation by third party (US and other government programs – CRDF, ISTC, IPP, FP6 etc.)
- R&D organized and led by well-educated, experienced managers.

Thank you,
and see you
soon in the
hydrogen future!