Centre for Energy Research

Utilization of nuclear power plants for hydrogen production

Attila R. Imre
(imre.attila@ek-cer.hu)

Methods for HYDROGEN production

Mature	**Promising**	**Lab-scale**
Electrolysis (alkaline) of *water*	Electrolysis (SOE) of *water*	Other biological (like fermentation) from *biomass*
Electrolysis (PEM) of *water*	Dry *methane* reforming/pyrolysis	Radiolytic decomposition of *water*
Steam *methane* reforming	Thermolysis of *water* (direct thermal decomposition)	Microbial electrolysis of fermented *biomass*
	Thermochemical decomposition of *water*	Artificial photosynthesis (photocatalytic process) of *water*
	Thermochemical decomposition of *organic material (fossile)*	
	Partial oxidation of *methane* (SynGas)	
	Coal gasification (with *water*)	
	Biomass gasification	

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Good hydrogen:

- From water or from renewable organic materials
- Zero or nearly zero carbon emission during the production

Three “products” of a nuclear power plant, which can be utilized for hydrogen production:

- Electricity
- Heat
- Radiation – probably not relevant, omitted here.

Utilization of heat:

- For thermolysis: at least 800-1200 °C, does not work with traditional reactors (water used as moderator, cannot reach degradation temperature!). Concerning novel reactors (molten salt/metal or He-cooled ones) the temperature can be reached, but transportation can be very difficult (long/safe distance transport, loss of heat, extensive amount of heat transfer material) .

Utilization of heat:

- For thermochemistry: special chemical reactions with multi-step water cracking. Temperature is slightly lower than for direct pyrolysis, but still quite high, 600-900 °C; might work for GEN-IV. Potential co-generation (heat for hydrogen production, electricity to grid). Extensive research for reactions running on lower temperature!

Utilization of heat:

- Biological/biochemical processes for hydrogen production, needs very low temperature (sometimes ever tertier waste heat can be utilized), but presently the efficiency is low. Only in laboratory-scale, probably far from the maturity. Extensive research on the increase of efficiency….might be the way of future.

Utilization of heat:

- Problem: in heat-based methods, usually hydrogen and oxygen are generated in the same location; explosive mixture, not favourable around nuclear installations.

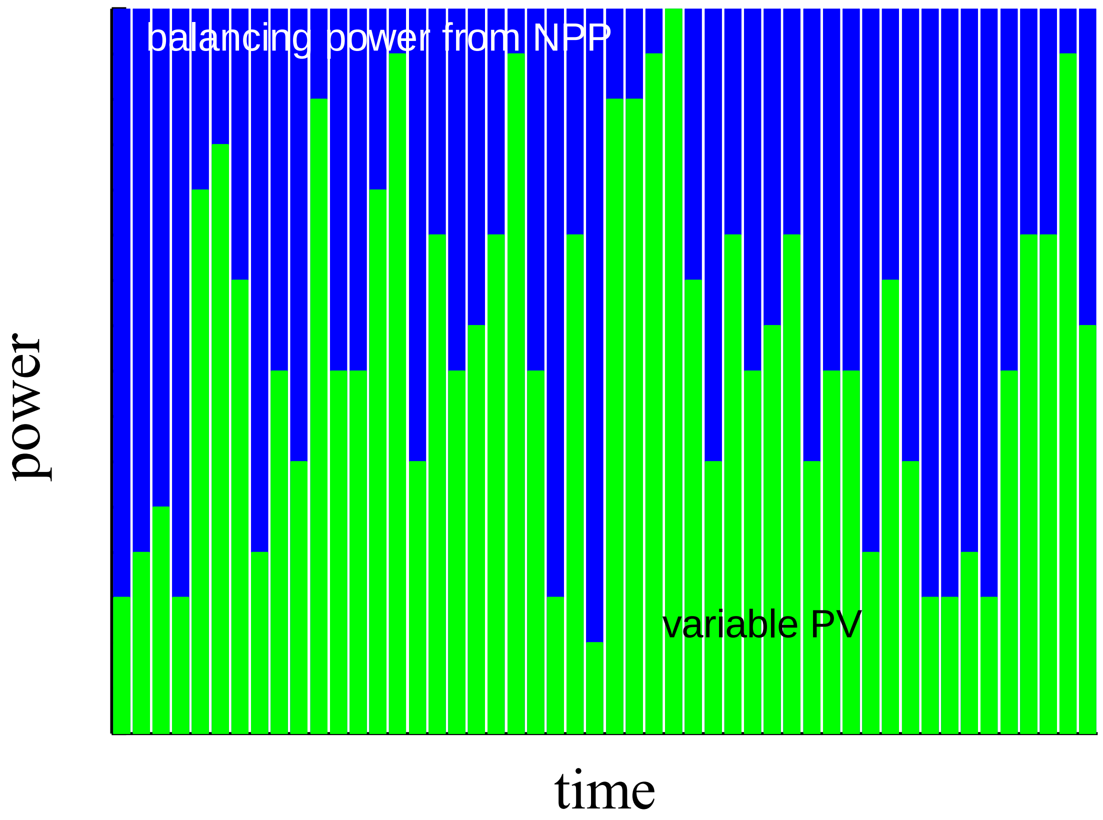
Utilization of electricity:
Electricity from NPPs is definitely carbon-free, more or less green (at least in the next few decades), although definitely not renewable. NPPs are baseload-plants, providing nearly constant power (hence the hydrogen-production would be predictable, unlike for most renewables, except geothermal-based one, where the capacity is usually too small).

PEM electrolyzers can handle fluctuating power (like PV-based), while alkaline (non-expensive) or SOE (very efficient) electrolyzers need constant power, hardly possible to provide with wind+solar.

- One can build huge PV-parks, where the “base” part of the power plus a small amount (smoothened by batteries) can go to SOE to produce a lot of hydrogen …. or ….
- One can use an existing or new NPP for the same purpose.

Infrastructure (for hydrogen transport) is usually better around NPP-s; costs, and public opinion is probably against them.

Potential solution: NPP + off-grid high-capacity PV (in the same location, i.e. only local grid needed):



Constant power, even alkaline electrolyzers (accessible!). Existing NPP-s with nearby PV-fields can be utilized immediately; for NPP-s without PV, the solar part can be built in a few months.

What is this? ..... a Nuclear Power Plant???

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Temelin

Presently for the production of industrial-quantity hydrogen with NPP-s, the NPP-levelled PV-based (partly renewable power) mass-electrolysis (probably alkaline- or SOE-type) can be a promising solution!

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Thank you for your attention!