Advanced Energy

BATTLE CARD

GREEN HYDROGEN

SOLUTION OVERVIEW

Net zero emissions is a global goal to be achieved in 2050. Green hydrogen will make a decisive contribution to this goal and will prove to be one of the most important energy carriers for the future.

At Advanced Energy, we are proud to be at the forefront of the green hydrogen revolution. Green hydrogen is produced by the electrolysis of water, a process that separates water into hydrogen and oxygen using electricity. This revolutionary process relies heavily on the efficient operation of electrolysers, devices that require robust and reliable power supply solutions. This is where our expertise comes into play. We provide dependable AC/DC power supply solutions that are essential in ensuring the smooth, uninterrupted operation of these electrolysers, playing a key role in the production of green hydrogen.

Advanced Energy´s current solutions:

- Thyro PX DC (SCR power controller)
- Artesyn iHP Series

Our solutions are one part built into the rectifier cabinet/container that is integrated, wired, and controlled multiple times. We do not provide turn-key solutions.

Target Markets/Customers

We strive to provide solutions for OEM electrolyser manufacturers and related system integrators.

- Enapter
- Sunfire
- Gen-Hy
- Hydrogen Pro
- H2Pro
- Hydrogenics (=> Cummins)
- Teledyne Energy
- Ohmium
- Advanced Ionics
- Evolve Hydrogen
- Cummins

Where to Avoid

Advanced Energy does not provide system “turnkey” solutions. Therefore we should at first avoid end-users or operators of electrolyser systems.

Audience – who to engage and when

- Customer type: OEM’s. Directors, Engineers, VPs, Technical decision makers.
- Customer size: of strong interest are both, big OEM customers as well as innovative small start-ups. As we are still in “learning mode” we like to be partner of all kinds of OEM customers.
- When to engage:
  Every H2 electrolyser manufacturer has it´s own technical approach that needs close and precise fitting of AE products during evaluation process.
  - Priority 1: Engagement in customer´s early technological evaluations or R&D stage to become initial source.
  - Priority 2: Engagement during customer´s operation stage to provide alternatives to existing solutions.

Business Benefits

- Our main business benefit valid for all kinds of customers is our customization capability and scalability by a modular device set-up.
- Our strong experience in power solutions can help OEM customers to focus on their core technology while having a reliable partner that can provide and evaluate best technical solutions.
- AE´s precise power solutions can be adjusted to customers requirements that vary from customer to customer and project to project
- AE provides a strong technical support and consultancy that is also beneficial for the customer during evaluation or R&D process.

Thyro PX Series

iHP Series

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INTERNAL CONTACTS

Michael Becker

Product Manager PCS · Industrial Power
michael.becker@aei.com
+491624126747

INTERNAL CONTACTS

Stuart Mitchell

Sr Director Engineering · Industrial Power
stuart.mitchell@aei.com

Qualifying Questions

- Please find out, preferably in advance, whether the customer is a producer of hydrogen or a manufacturer of electrolysis systems.
- As we are focusing on electrolyser manufacturer OEMs we need to figure out what technical approach the customer is using. At the moment we focus on PEM electrolyser customers but can also deal with alkaline technologies.
  - What kind of electrolyser does the customer manufacture (Alkaline, PEM=Polymer Electrolyte Membrane) or SOE (Solid Oxide Electrolysis)?
  - What general power level is required? The required voltage and current level will guide us to either SCR based technology like the Thyro PX for higher power levels or to switch mode power supplies like the iHP for lower powers. Please refer to actual product data sheets for exact power levels and other specifications.
  - Are DC output ripples of relevance or of minor importance? What ripple value is acceptable?
  - What different devices should be combined to achieve a certain power / voltage or current level?
  - Does the system need to be upgradable in the future? What are the required and related conditions?
  - What is the requested overall system efficiency and can this be achieved with our solutions / components?

Customer Challenges

1. Reliable power supply unit.
2. Power supply efficiency and overall system efficiency.
3. Lowest possible output ripple.
4. DC Voltage Ripple and Harmonics (THD) are influencing the efficiency of the electrolyser by causing excitations of the ions in the electrodes. The effect causes heat which then influences the electrolyzing efficiency.
5. Cost efficiency as green hydrogen production needs to be competitive against alternative fossil based energy or importation of green H2.

Key Features & Specs (high-level differentiators)

Thyro PX Series:

1. Flexible high power AC-DC Thyristor for different power levels allow for flexibility in terms of electrolyser capacity or modular principle.
2. Cost-effective solution
3. Robust technology with proven long-term reliability.

iHP Series:

1. Modular principle for the ability of multiplying electrolyser systems.
2. Very low DC output ripple ~0,008 V @ 150V.
3. Customization possible to operate system as AC-DC or DC-DC converters.

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COMPETITIVE ANALYSIS

INTERNAL CONTACTS

Frank Sohn

Sr Strategic Marketing Manager · Industrial Power

frank.sohn@aei.com

Competitors	Friem, Cummins (formerly Hydrogenics), Nel, Dynapower, & Spang Power Electronics
Their Positioning & Selling Points	▪ Providing customized high power solutions and systems that are specially designed for the hydrogen market. ▪ Expert in high power solutions. ▪ Most of our competitors can provide references in the hydrogen business and are involved with the big players.
Our Differentiation	▪ We can deliver components in higher quantities according to customer´s demand with reliable quality and delivery time. ▪ We can provide customized solutions according to customers requirements and technical expectations. ▪ We are not limited to any fixed technical output values. With our modular design we can cover a broad range of requirements that enable our customers to pursue their unique technical approach.
Comparative Positioning	▪ Market for high power components relatively small. ▪ PCS has a good experience in high power design. Customer requirements and special environmental conditions can be included in customized product design and, if necessary, brought to series / OEM production. ▪ Customized DC/DC solutions available to provide a maximum of flexibility.

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ADDITIONAL REFERENCES

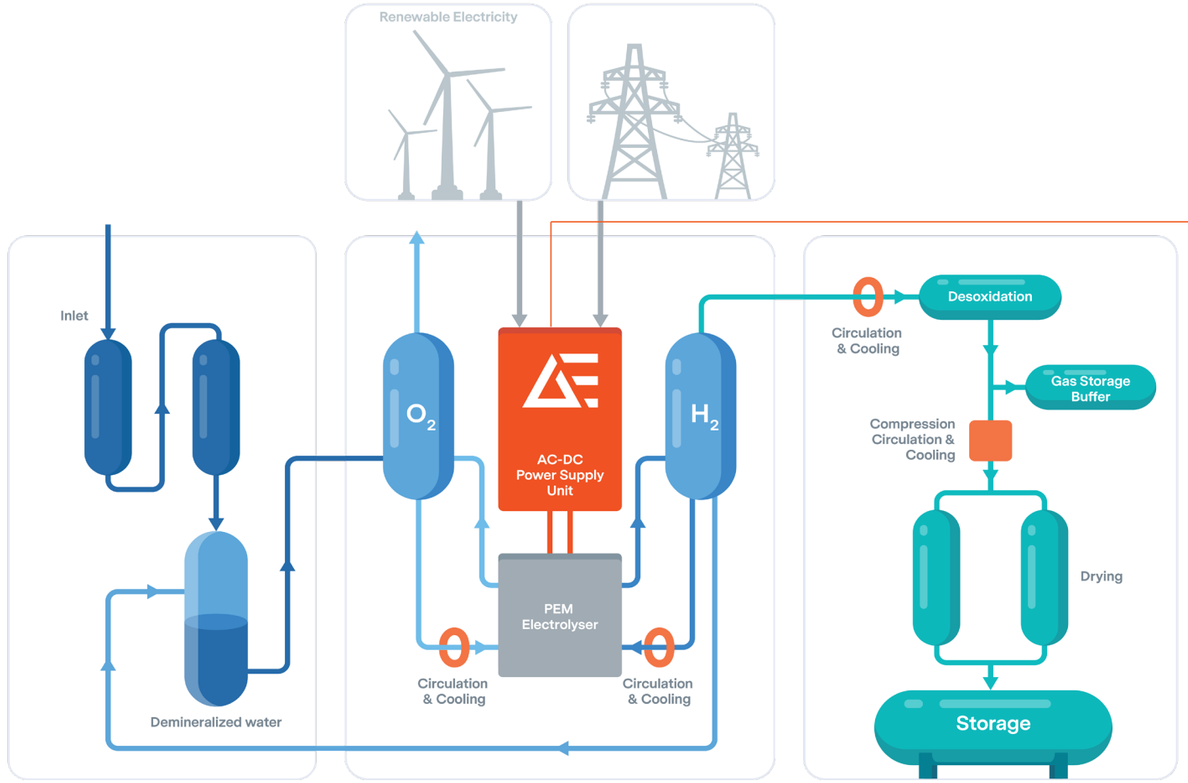
INTERNAL CONTACTS

Patrick Rellecke

Account Manager · Global Sales

patrick.rellecke@aei.com

System Block Diagram



Cross-Selling Opportunity: CSC & IPC Group