## Delivering Energy to Mini-Grids and Vehicles Independently of Existing Transmission Systems

It is important to advance cyber-physical systems that harness ephemeral ambient energy and buffer that energy. Ambient energy is independent from existing transmission infrastructures. Such systems improve energy security because they make certain aspects of the energy grid redundant. Two examples are a framework that delivers off-grid energy to customers (I) and a system that sustains an energy-exporting microgrid (II).

I. For example, recent work in hydrogen airship safety [1] theoretically allows hydrogen-versions of cargo airships to not only buffer *remotely*-harnessed energy as hydrogen, but to also deliver energy buffers independently of existing energydistribution infrastructures. Cargo airships can deliver hydrogen lifting gas directly while simultaneously delivering cargo.

Research needs include:

- Docking or packetized shuttling to load and unload hydrogen from hydrogen cargo airships [Cf. 3]
- Optimally scheduling
- II. For another example of buffering energy parallelly and independently from existing transmission infrastructures, consider cyber-physical systems that deploy to harness transiently available renewable energy and to store it, and then stow themselves to be unobtrusive. Research has shown that wind systems can be stowed for the majority of the time while still harnessing the majority of available wind energy [4]. Such systems seem well-suited to be installed near existing distribution grids, which could act as self-sustaining microgrids if energy were practically stored. Once the mirogrid fills its buffers and if transmission lines are available, it could export its excess.

Research questions include:

- Integrating such cyber-physical systems into residential neighborhoods and industrial parks
- Monitoring the health of such integrated systems [5]

## **References:**

[1] Trancossi, Michele, et al. "Fire-safe Airship System Design." SAE International Journal of Aerospace 5.1 (2012): 11-21.

[2] Gadola, Guy, and Panos Chrysanthis "Harnessing Off-Grid Renewable Energy" International Conference on Renewable Energy Research and Applications (ICRERA) 2013.

[3] Dumas, Antonio, et al. "Multibody advanced airship for transport." Health 2012 (2011): 03-12.

[4] Mosse, Daniel, and Guy Gadola. "Controlling wind harvesting with wireless sensor networks." *Green Computing Conference (IGCC), 2012 International.* IEEE, 2012.

[5] Lee, Jay "Recent Advances of Prognostics and Health Management in Renewable Energy Applications" International Conference on Renewable Energy Research and Applications (ICRERA) 2013