6TH ANNUAL AMMONIA FUEL CONFERENCE

OCTOBER 12-13, 2009

KANSAS CITY, MO

"A MARYLAND AMMONIA PROJECT"

WILLIAM H. KUMM, PRESIDENT, &

ST. JOHN MARTIN, VICE PRESIDENT,

ARCTIC ENERGIES LTD.

ARCTIC ENERGIES

MARYLAND

MULTI-ELEMENT

OPERATIONAL

NON-CARBON-FUEL

INNOVATIVE

APPROACH

For: "A CLEAN, GREEN, ECONOMY"

By: ARCTIC ENERGIES LTD. (AEL)
SEVERNA PARK, MD 21146-1010 Y2009

ARCTIC ENERGIES LTD IS:

A Maryland Professional Engineering Corporation Focused on "Green Energy" for the last 28 years.

Successful in multiple, Federal Small Business Innovation Research (SBIR) Contracts.

Phase III SBIR Sole-Source contracted technology-developer for the USCG on "Green Ship" Powering.

Contractor to the DOE for Solar Energy Conversion Technology Development.

Holder of 7 US Patents and 2 Registered Trademarks.

Professional "Clean Energy" Conference Participant.

Conversant and experienced in Interfacing with Staffs of State and Federal Agencies and Members of Congress.

Maryland:

- Enjoys unique Political and Geographic Qualifications as the Congressional District 1 that spans both the Western and the Eastern Shores of the Chesapeake Bay.
- Has 2 Federal Congressional Democratic Senators.
- Has just elected a new District 1 Representative to Congress, Frank Kratovil.
- Has a Democratic Governor, Martin O'Malley.
- Receives strong support for "Green Energy" projects from the Maryland Energy Administration (MEA).
- Has a University System (UMD) that is familiar with "Green Energy" approach on both shores of the Chesapeake.
- Has a Port Authority (MPA) that has considered "Clean Energy" thinking in the past.
- Has a Maryland Science Center eager for "Green Energy".

MULTI-ELEMENT

- **Energy Fuels, both carbonaceous and non-carbon "Green"**
  - **Ethanol from agricultural biomass - corn**
  - **Biodiesel from " " - soybeans**
  - **Pure Hydrogen**
  - **Ammonia as a fuel**
- **Energy Conversion Technologies**
  - **Diesel Engines using biodiesel fuel**
  - **Gas Turbines using biodiesel fuel**
  - **Fuel Cell power plants using biodiesel fuel**
  - **Modified Diesel Engines equipped to use ammonia fuel**
  - **Fuel Cells that are built to operate with ammonia fuel**
- **Land-based installations; rail, highway, fixed, agricultural**
- **Sea-based (marine) platforms and ships**

Operational

- "Green Energy" tradeoffs are not always intuitively obvious.
- Government agency charters may not precisely match societal problems.
- Cross-cutting evaluations and studies are needed.
- Evaluation criteria can change with time.
- Funding tends to lag identified needs.

AEL's operational approach is to encourage and facilitate the introduction of "carbon-free" fuels into the Economy.

Non-Carbon-Fuel

- Historically Carbon-based fuels have included: wood, peat, coal, ethanol, petroleum, (gasoline, diesel fuel and natural gas).

- When burned all these "classical" fuels bind their Hydrogen to produce water vapor (H_2O). However, the Carbon creates Carbon Dioxide (CO_2), the world's major atmospheric Global Warming air pollutant.

- Spent nuclear fuel is radioactive for eons and must be buried.

- Ammonia is a Carbon-Free fuel. NH_3 is a "Hydrogen-Carrier"fuel. It routinely moves in commerce now as an agricultural fertilizer, but has not also been thought of as a fuel until quite recently.

- When NH_3 is burned the Hydrogen binds with Oxygen from air to produce water vapor (H_2O), and the Nitrogen returns to air (which is is mostly Nitrogen anyway). Thus, <u>No Global Warming occurs.</u>

Innovation

IN REGARD TO "GREEN" ENERGY PROJECTS, BOTH NATIONAL AND WITHIN MARYLAND, STARTING ON THE EASTERN SHORE.

- The constituents of Ammonia are:
- Nitrogen from air. (The air we breathe is actually 78% Nitrogen, or "N2").
- Hydrogen from water. 71% of the Planet Earth's surface is covered by water i.e. the Ocean is H2O.

- Using solar energy captured at the sea surface, and cold ocean water from the deep, the thermal gradient provides vast amounts of "Green Energy", **Ocean Thermal Energy Conversion.**

APPROACH

The world needs to seriously reduce the amount of Carbon Dioxide air pollution by using clean fuels.

The solar energy impinging on the surface covered by the World's oceans provides totally renewable energy.

Making Ammonia fuel at sea on Plantships creates this "Hydrogen Carrier, Green Fuel" in the quantities needed for all of the World's energy needs.

The NH_3 would then be moved in bulk in NH_3-fueled tankers. Most of the World's population reside within 100 miles of an ocean, and are familiar with energy fuel deliveries by sea.

On land the NH_3 would be pipeline delivered, or bulk barge and/or rail tank-car delivered, as NH_3 already is today.

CARGO OPTION: NH_3 55,000 mt @ -33° C

"CAPTAIN MARKOS NL" Bahamas Registry, 16 kn, 18,420 bhp

Ocean Thermal Energy Conversion (OTEC)

- **OTEC was the initial effort for producing green energy, where large plant ships would use sun warmed ocean waters for producing ammonia and fresh water and send the two liquids ashore in tankers for distribution through the existing pipelines, barges, trucks and rail car infrastructure. However, the Government backed off funding for these projects.**

The Land-Based Approach

- **An alternative program was then designed that would also use solar power, but in the form of wind turbines and/or photovoltaic collectors.**
- **Farms on the Eastern Shore of Maryland are great locations for the installation of turbines and photovoltaic panels without interfering with crop or livestock production.**
- **Government grants and tax credits are available now to offset costs.**

Non-Grid-Tied Energy

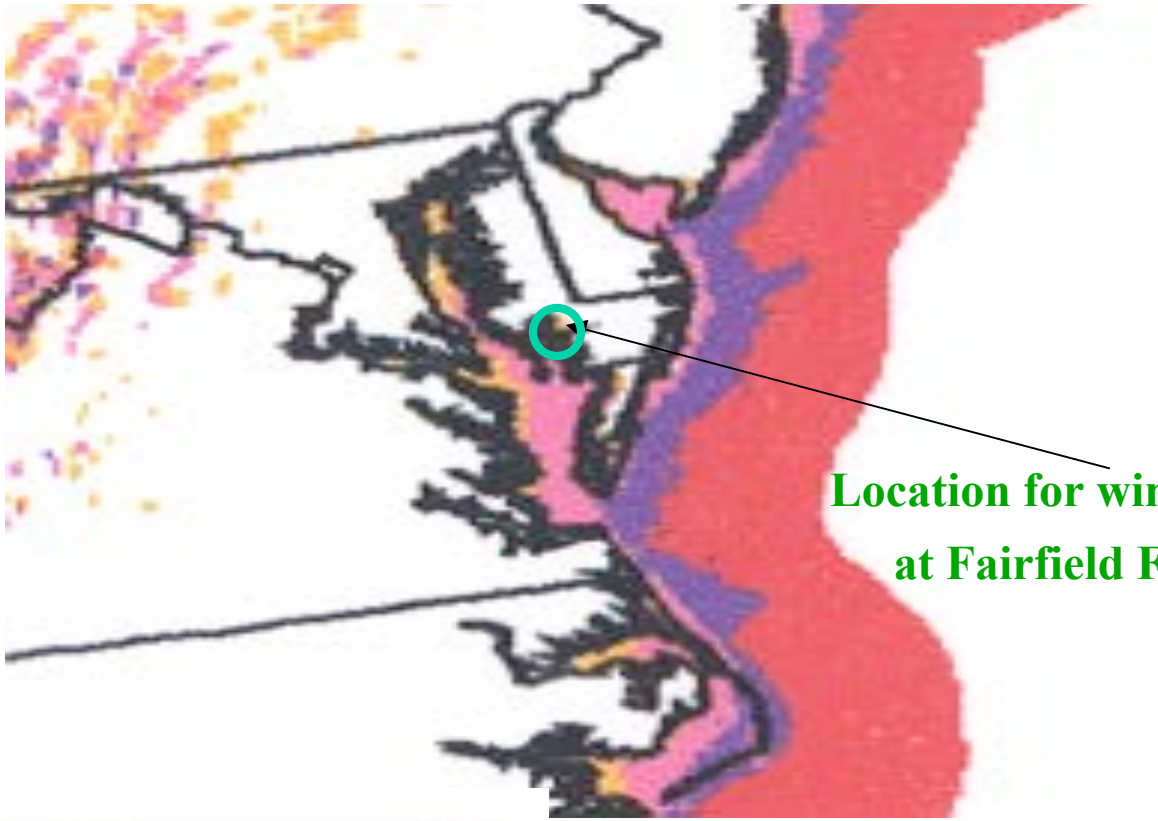
- This project is aimed at energy generation not tied to the power grid.
- Electricity generated by the wind and solar cells will power the farm, but excess energy will be diverted to making ammonia.
- Ammonia will be stored for consumption in road and farm vehicles, electric generators, and as fertilizer for crops.

The Abell Foundation

- The Abell Foundation has supported projects to improve the environment of Baltimore for 100 years.
- State and Federal money can be granted to the Abell Foundation and then directed to green projects such as the wind and solar project at the Luthy farm.

FAIRFIELD FARMS EASTERN SHORE SITE

Chesapeake Bay, MD Eastern Shore, Dorchester County



Wind Power Classification

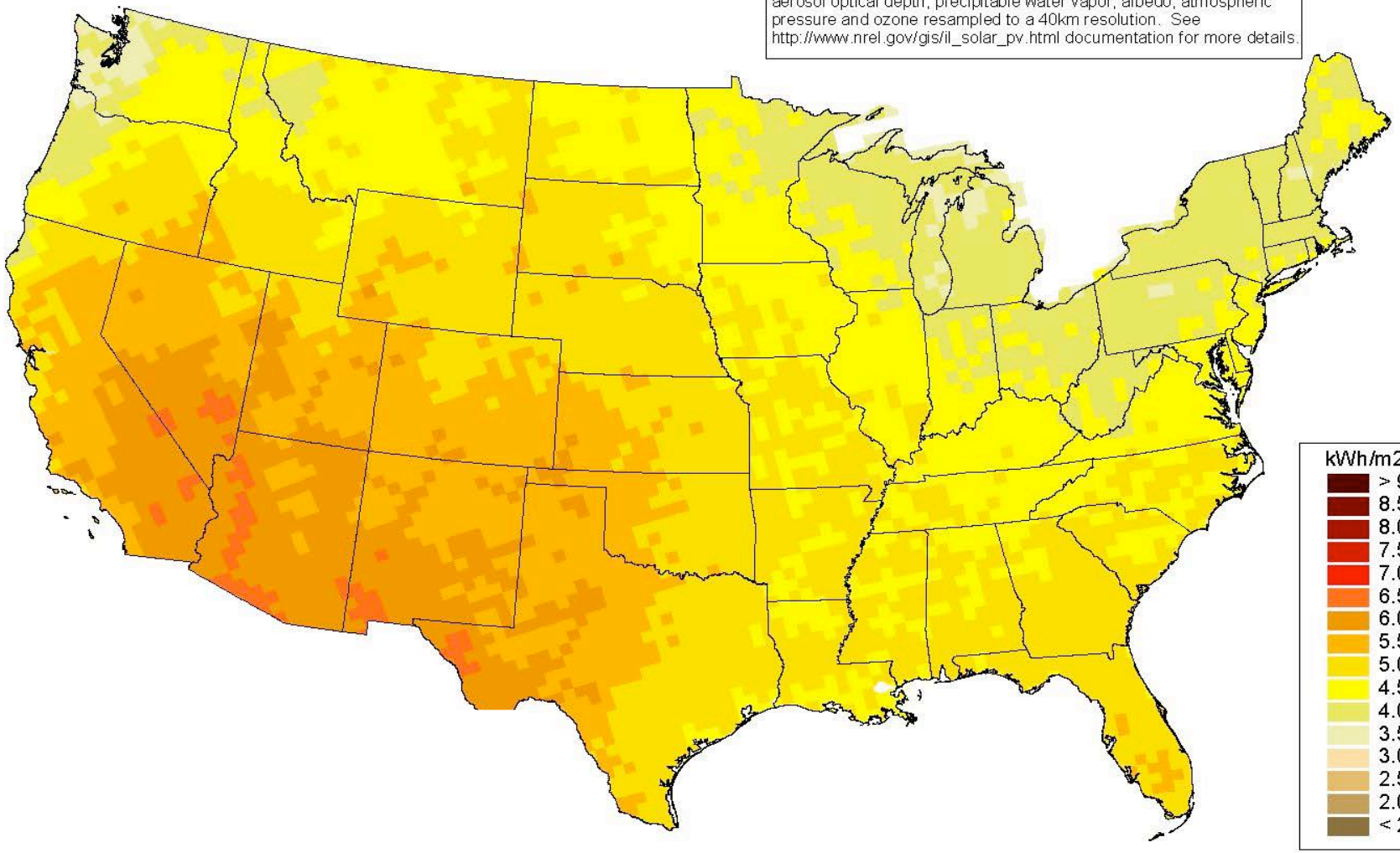
Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

[a] Wind speeds are based on a Weibull k value of 2.0

PV Solar Radiation
(Flat Plate, Facing South, Latitude Tilt)

Annual

Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40km resolution. See http://www.nrel.gov/gis/il_solar_pv.html documentation for more details.

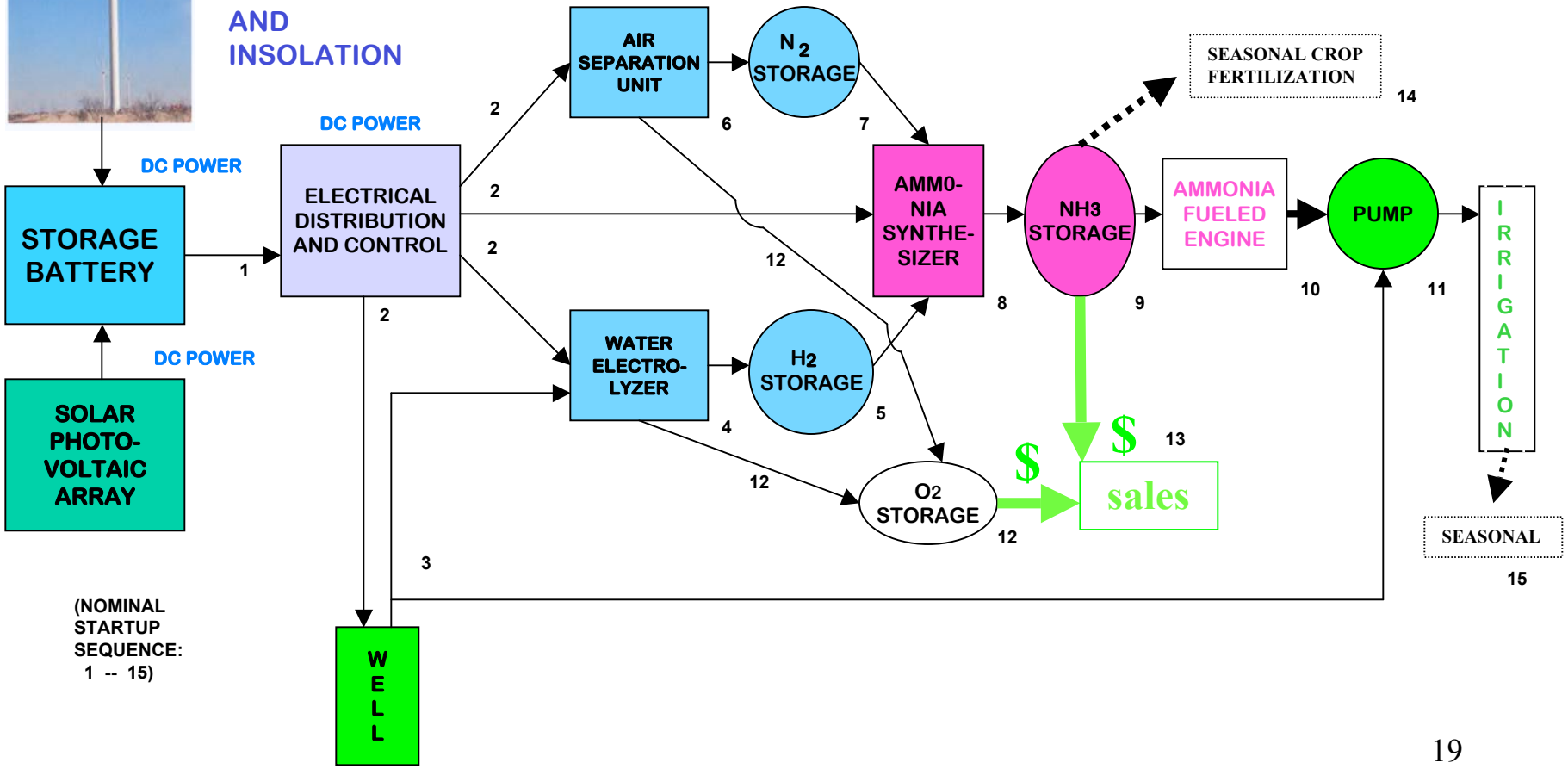


Power output adjusted for DC-to-AC conversion losses and fixed-tilt, non-tracking photovoltaic arrays at Fairfield Farms is 3.1 kwh/m^2/day

Produced by the Electric & Hydrogen Technologies & Systems Center - May 2004

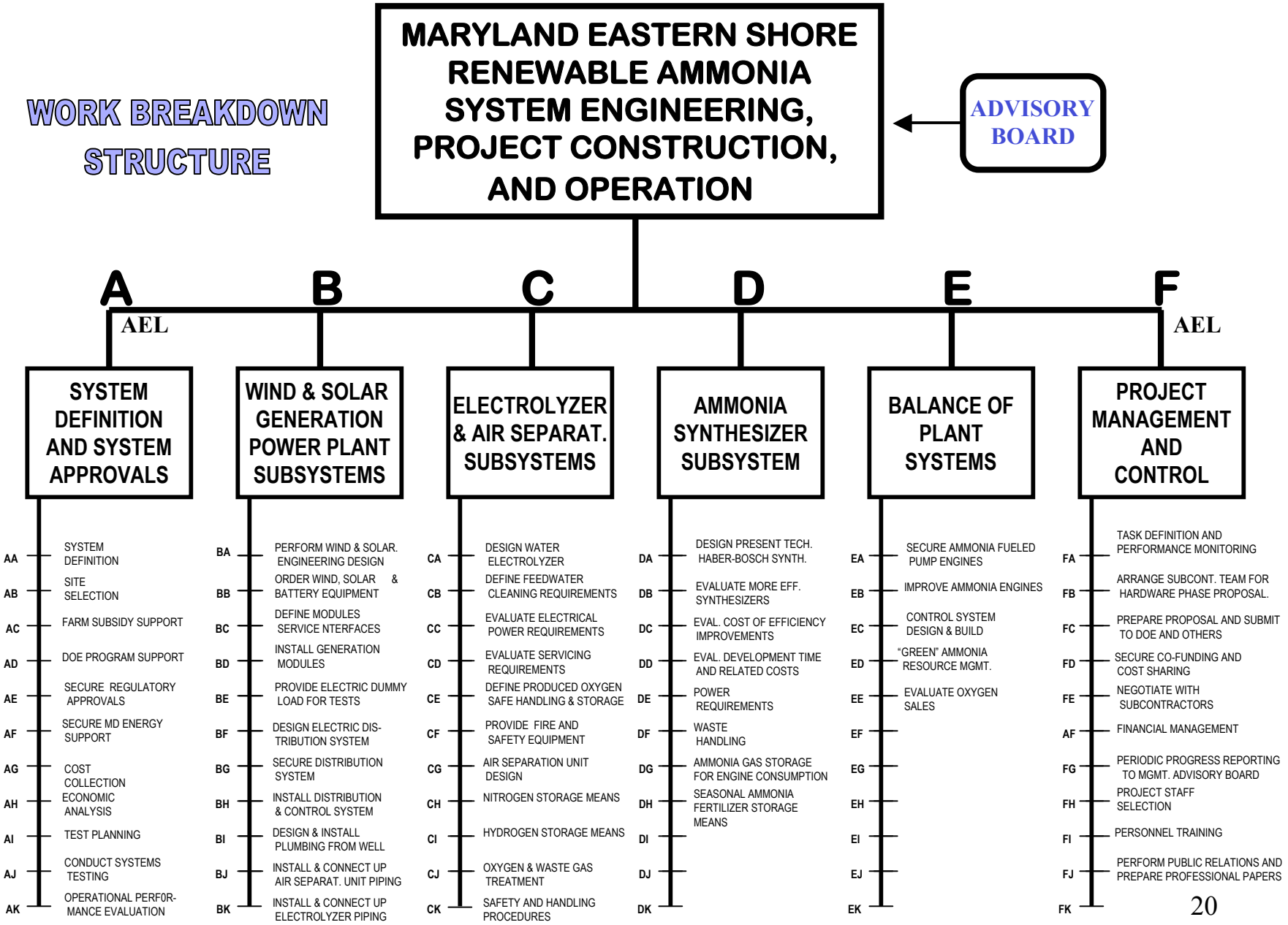
COMPLEMENTARY RENEWABLE ENERGY OPTIMIZATION

ELECTRICITY GENERATED BY BOTH WIND AND INSOLATION



(NOMINAL STARTUP SEQUENCE: 1 -- 15)

WORK BREAKDOWN STRUCTURE



GE Energy

1.5 MW Wind Turbine
The Industry Workhorse

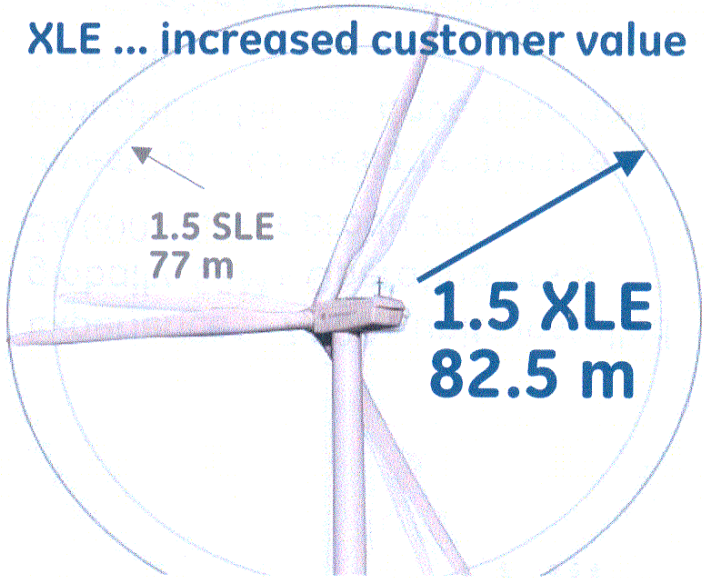
Arctic Energies LTD

Katy Wilner
July 22, 2009

GE imagination at work

Building on the *The Industry Workhorse*

XLE ... increased customer value

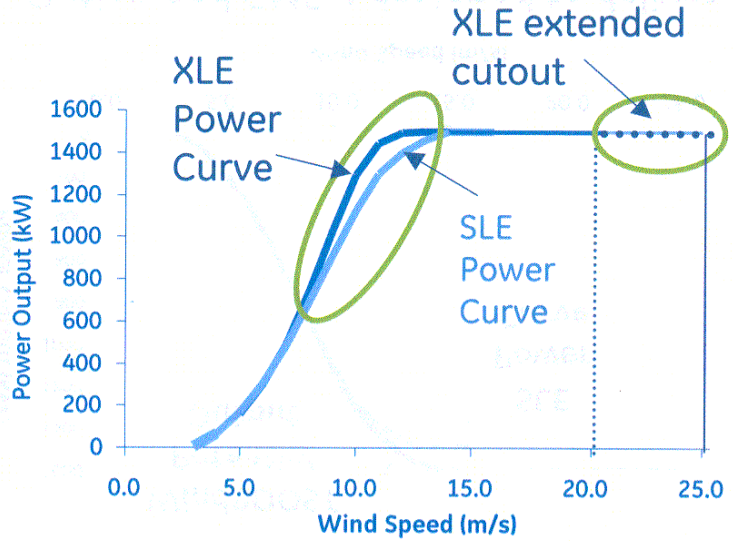


- Greater energy capture ... 15% larger swept areas than SLE
- Increased capacity factor ... +3pts GCF @ 8m/s

Delivering 7% more AEP @ 8m/s ...

XLE ... platform evolution

- Leverage 1.5 MW experience ... GE technology
- Expanding wind regimes ... TCIIb, 25m/s cut-out



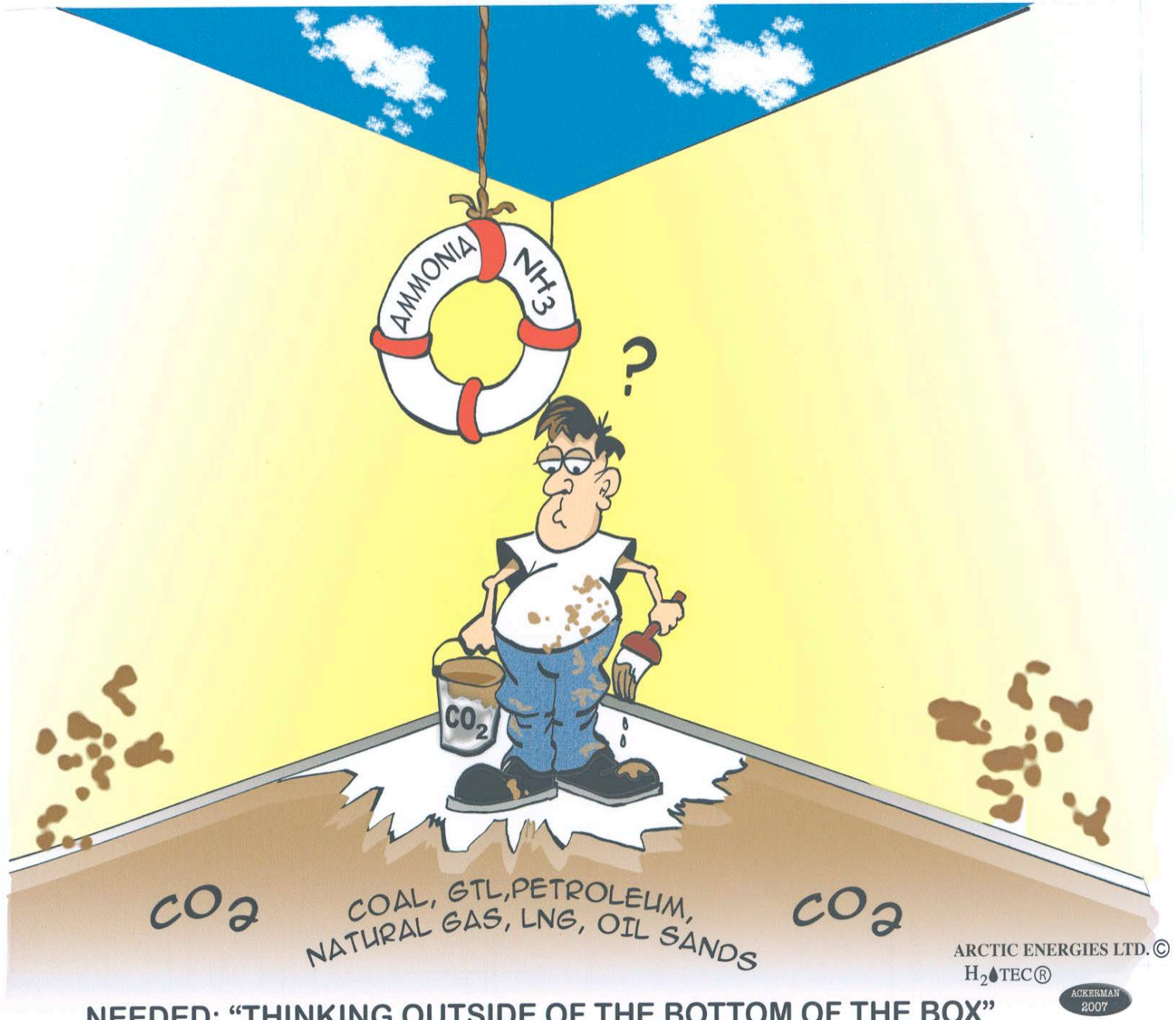
... developing 7% more AEP @ 8.5m/s

A POSSIBLE AMMONIA FUELED SHIP

Ship Power

- A cruise ship line operates out of Baltimore harbor and uses diesel engines for propulsion.
- These engines could be converted to run on ammonia.
- While at the dock, the ammonia powered engines could produce electricity to power the nearby Maryland Science Center which purchases about 30 megawatts for its operation.
- Each ship could generate up to 4 megawatts of non-polluting, non-carbon-based electricity.

THE NON-CARBON FUEL WAY OUT



NEEDED: "THINKING OUTSIDE <u>OF THE BOTTOM</u> OF THE BOX"