

THE HYDROLLEY

(HYDRAIL TRAM)

**Presentation to the
Fourth International Hydrail Conference
Valencia, Spain — 9 June 2008**

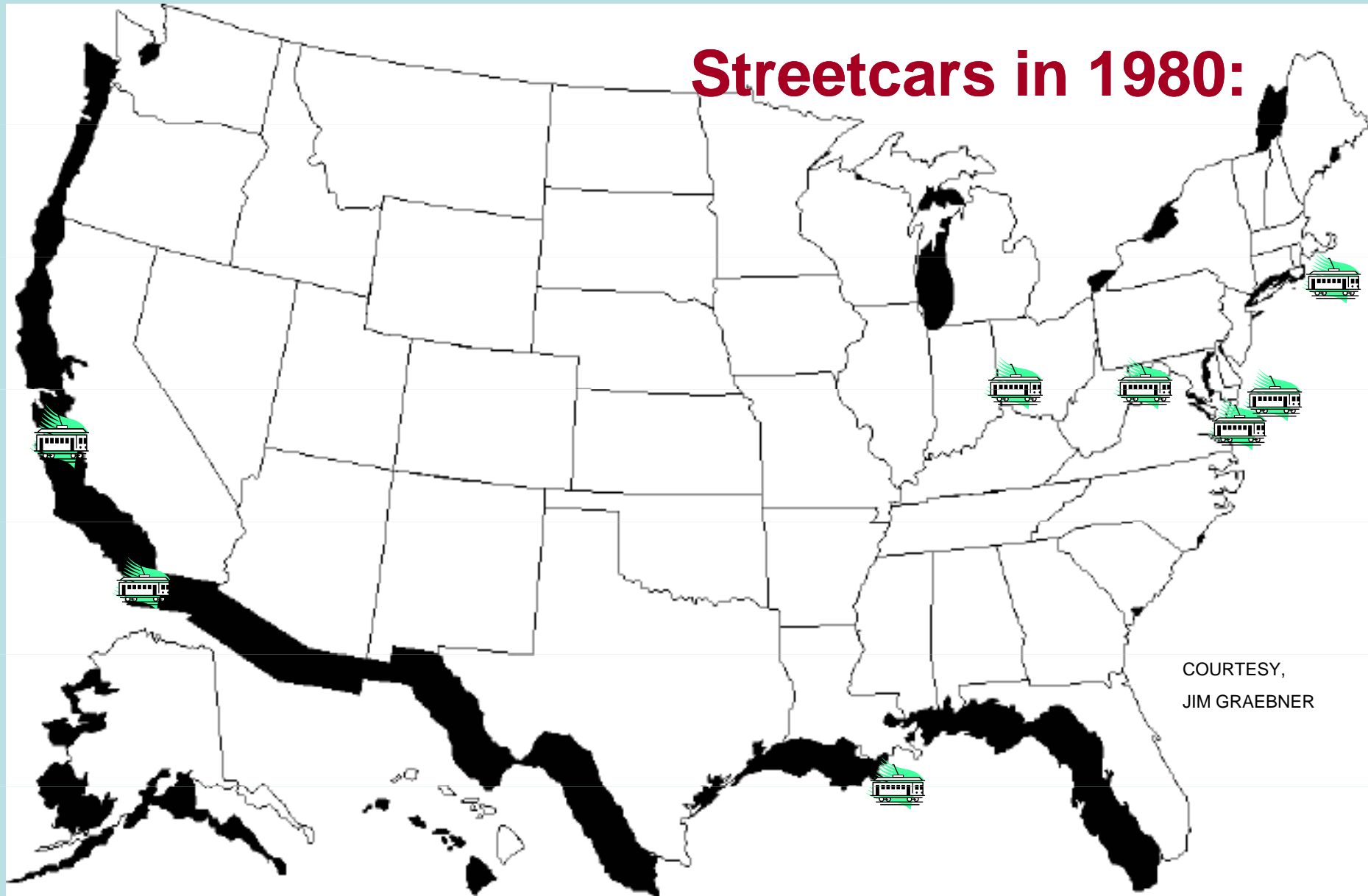
**by Stan Thompson—chairman, “HEAT”
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ACKNOWLEDGEMENTS

James Graebner, chairman of the Trolley Committee of the American Public Transportation Association, created the PowerPoint slides on present and future deployment of streetcars included here. Their use reaffirms Mr. Graebner's perspective. We hope to show how the advent of "hydrolleys" — hydrogen fuel cell streetcars — can bring about streetcar reintroduction much sooner and at far less cost than has been possible until now.

Jean-Paul Moskowitz of Alstom, France, described a hydrolley concept, "Fulltram," at the Hydrogen Train Conference in Herning, Denmark, in 2006.

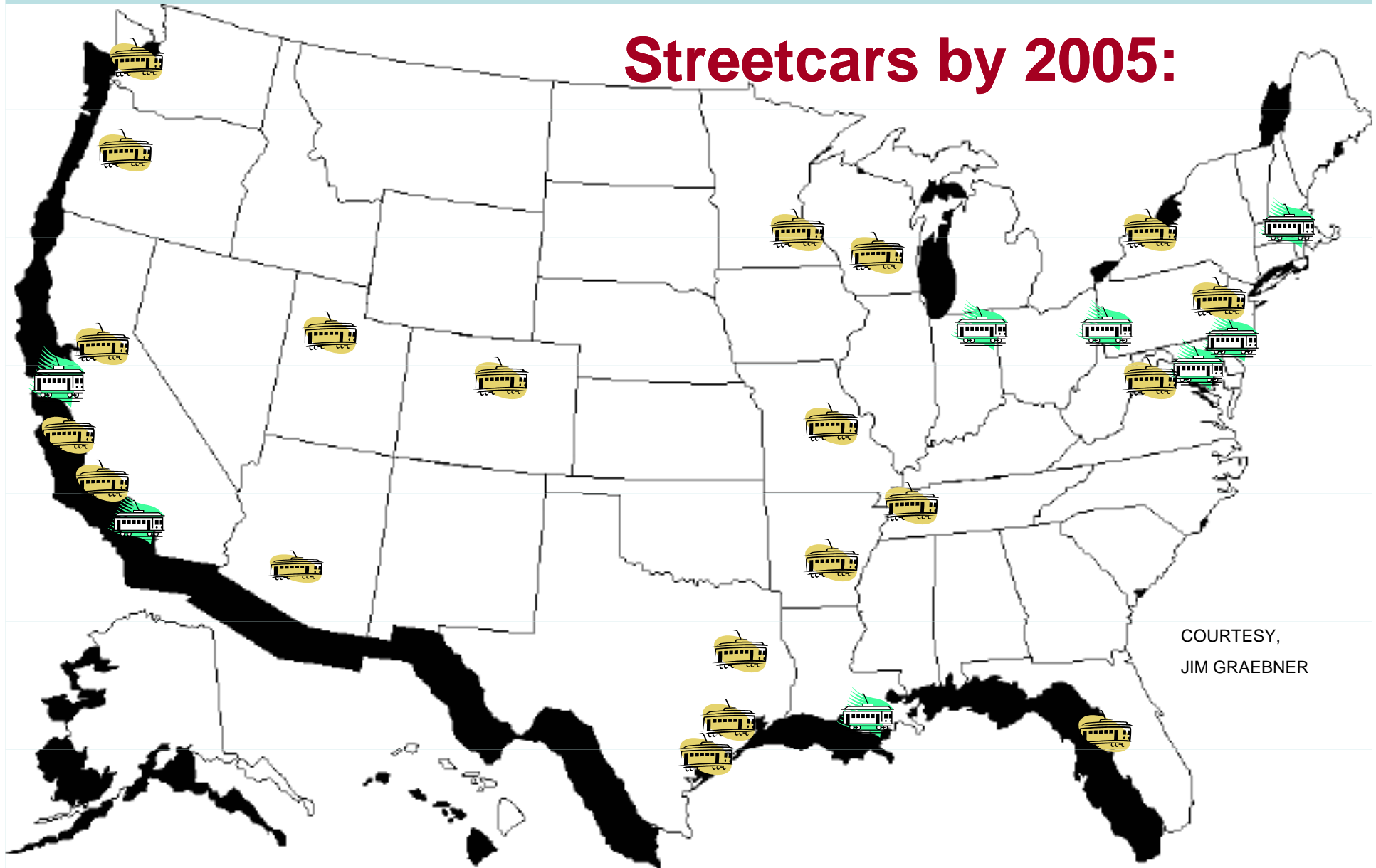
Streetcars in 1980:



COURTESY,
JIM GRAEBNER

San Francisco, New Orleans, Philadelphia , Newark, Cleveland, Boston,
San Diego, Pittsburgh

Streetcars by 2005:



COURTESY,
JIM GRAEBNER

San Francisco, New Orleans, Philadelphia, Newark, Cleveland, Boston, San Diego, Pittsburgh, San Jose, Sacramento, Portland, LA, Houston, Denver, Salt Lake City, Buffalo, St. Louis, Galveston, Tucson, Seattle, Dallas, Little Rock, Memphis, Tampa, Baltimore, Lowell, Minneapolis, Kenosha

Seattle, Portland, Salem, San Francisco, LA, San Diego, Tucson, Phoenix, Albuquerque, Denver, Colorado Springs, Spokane, Boise, Salt Lake, Sacramento, Austin, Houston, Corpus Christi, Kansas City, St. Louis, Des Moines, Minneapolis, Kenosha, Madison, Omaha, Chicago, Little Rock, Memphis, Dayton, Toledo, Cincinnati, Columbus, Lancaster, Philadelphia, Newark, Providence, Kinston NY, DC, Richmond, Roanoke, Atlanta, Savannah, Birmingham, Miami, Tampa, Grand Rapids, Boston, Lowell, French Lick Indiana, Charlotte, NC.

PLANNED STREETCAR SYSTEMS:



COURTESY,
JIM GRAEBNER

San Francisco, New Orleans, Philadelphia, Newark, Cleveland, Boston, San Diego, Pittsburgh, San Jose, Sacramento, Portland, LA, Houston, Denver, Salt Lake City, Buffalo, St. Louis, Galveston, Tucson, Seattle, Dallas, Little Rock, Memphis, Tampa, Baltimore, Lowell, Minneapolis, Kenosha



Somewhere between these pictures...



Outbound F-Market PCC car crosses Church St. at Market.

...and *this* picture is the reality of overhead trolley electrification.



Hydrogen fuel cell hydrololeys won't need it.



THE HYDROLLEY DIFFERENCE

- *no catenary*—leaves municipal utility plant “buried in peace.” On-board fuel cells eliminate the need.
- *no poles needed*
- *no substations*
- *no complex grounding*
- *less exposure to copper price escalation*



HYDROLLEY ADVANTAGES:

- **Avoids \$1.5 - 2.5 million capital investment per mile of track by eliminating track electrification.**
- **Avoids interference problems when tall equipment like cranes must be moved through cities.**
- **Eliminates the maintenance costs, shock hazards, weather, and security vulnerability of overhead power systems.**



MORE STREETCARS, SOONER:

- **Substantially reduced fixed plant cost “lowers the funding bar.”**
- **Clean, hi-tech *panache* can attract young and Green ridership.**
- **If cities now planning streetcar systems collaborate and plan, R&D and manufacturing can proceed more rapidly; major scale economies can be obtained.**



HISTORY FORCES THE ISSUE:

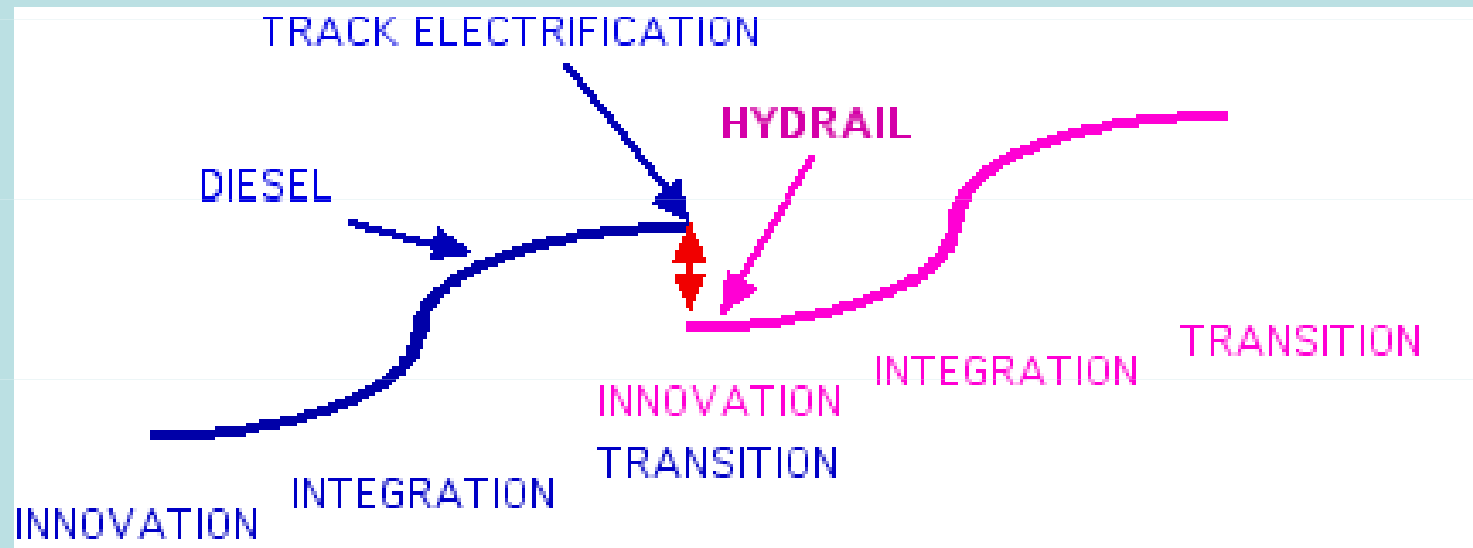
- Once the first hydrolley is deployed *anywhere*, catenary plant and trolley rolling stock sources may begin to dry-up.
- Like the steam-to-diesel transition, change tends to strand the last old-tech investment—undepreciated and short-lived.
- Europe and North America need reasoned, generally accepted, hydrolley introduction plans and policies.



ENGINEERING ECONOMICS ALSO FORCES THE ISSUE:

- **Prediction: Once the first hydroolley is in revenue service, US Federal policy makers will draw a cutoff date, beyond which no new track electrification projects will be Federally funded.**

THE NATURE OF TECHNOLOGY CHANGE:
TRANSITION IS A
DANGEROUS, AMBIGUOUS TIME.



AT SOME POINT, THE RISK OF HESITATING IS
ACTUALLY *GREATER* THAN THE RISK OF
INNOVATING, BUT STILL *SEEMS* LESS SCARY.

“It seemed like a good idea
at the time....



***Evening Star* Standard 9F heavy freight engine, built 1960**


- The last mainline steam engine built in Britain
- Planned to work for twenty years, only used for five

National Railway Museum, York, UK



ANTICIPATED *PENALTIES* OF HYDROLLEY LINES:

- **Needs fueling infrastructure not needed by trolleys.**
- **Needs on-board fuel, fueling stops...sites...labor to fill.**
- **The regulatory world is molded around 120 year old heritage trolley technology; needs reworking.**
- **The Hindenburg “folk hoax” just refuses to die.**



HYDROLLEY UNKNOWNNS:

- **Can electrified lines be extended beyond catenaries by adding hydrolley equipment?**
- **Can abandoned freight spurs and sidings affordably become part of hydrolley lines where electrification would have been cost-prohibitive?**



VEHICLE OPTIONS

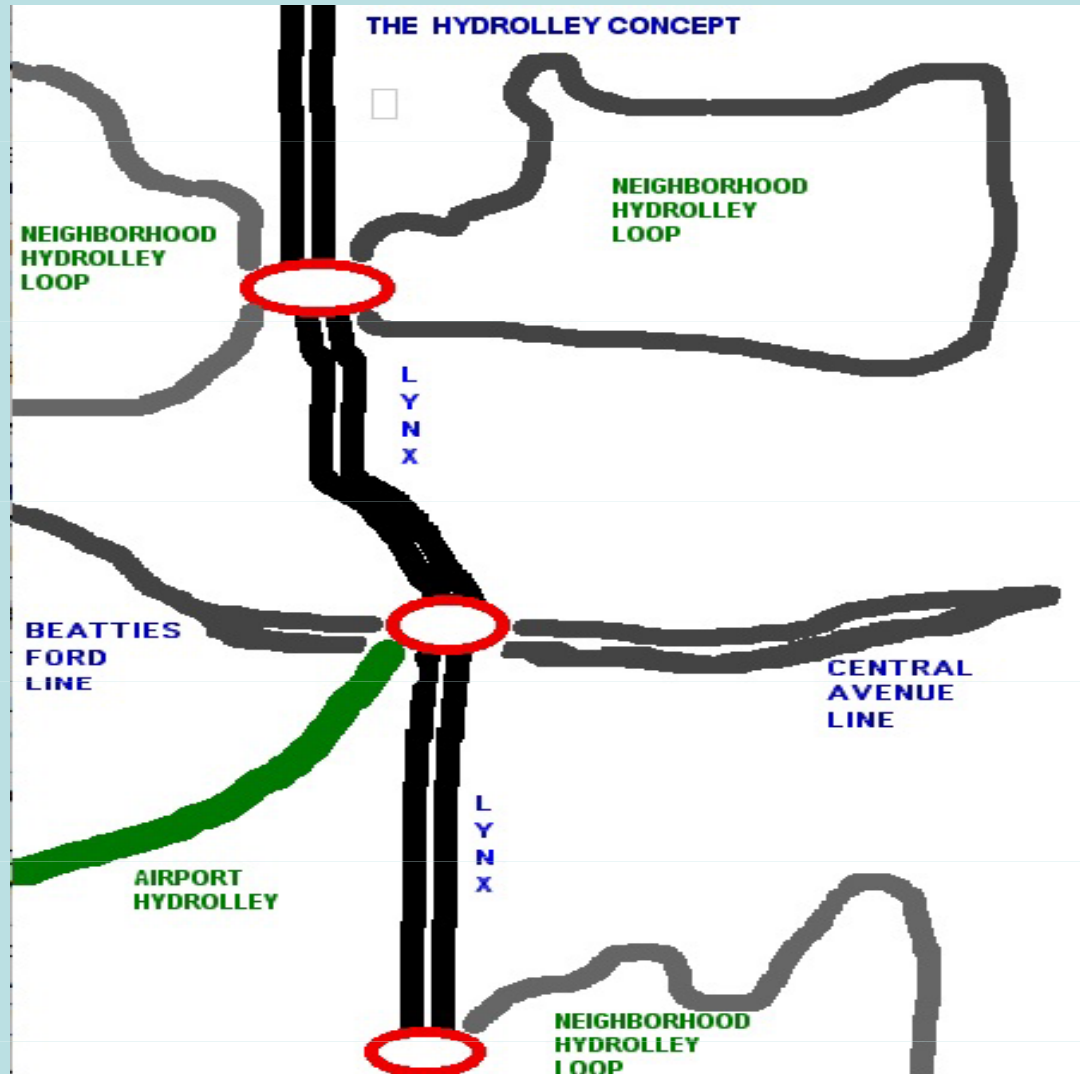
- **New-from-the-ground-up hydrolleys (the Mooresville MES product as contemplated)**
- **Heritage retrofit to hydrolley tech (pioneered in Surrey, BC, CA)**
- **Heritage replica hydrolleys designed new around hydrail technology; produced and parts-supported in volume.**
- **Mixed fleet: heritage *and* modern equipment on same line.**



MOORESVILLE'S VISION

- Mooresville, NC, USA, is recruiting Proterra LLC of Golden, Colorado, USA, to build the world's first hydrolley factory and satisfy demand both in North America and abroad.
- If we succeed, Mooresville-built hydrolleys will:
 - -be designed from the ground up around battery-dominant fuel cell technology;
 - -use lithium titanate batteries that operate over a 10% to 95% state of charge range; accept 10,000 full charge/discharge cycles; allow use of much smaller and less expensive full cells; charge in as little as ten minutes; recapture 80% of braking regeneration; allow fuel cells to run at near-constant "sweet spot" output for much longer life; not be subject to lithium ion fire hazards;
 - -use composite bodies that reduce vehicle weight by 30%.

SOME ANTICIPATED HYDROLLEY ALIGNMENT EXAMPLES



(Charlotte, NC, is the hypothetical model)

**presented with thanks from Mooresville and HEAT
to JAMES H. GRAEBNER and APTA**



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