

BIOGAS CONVERSION

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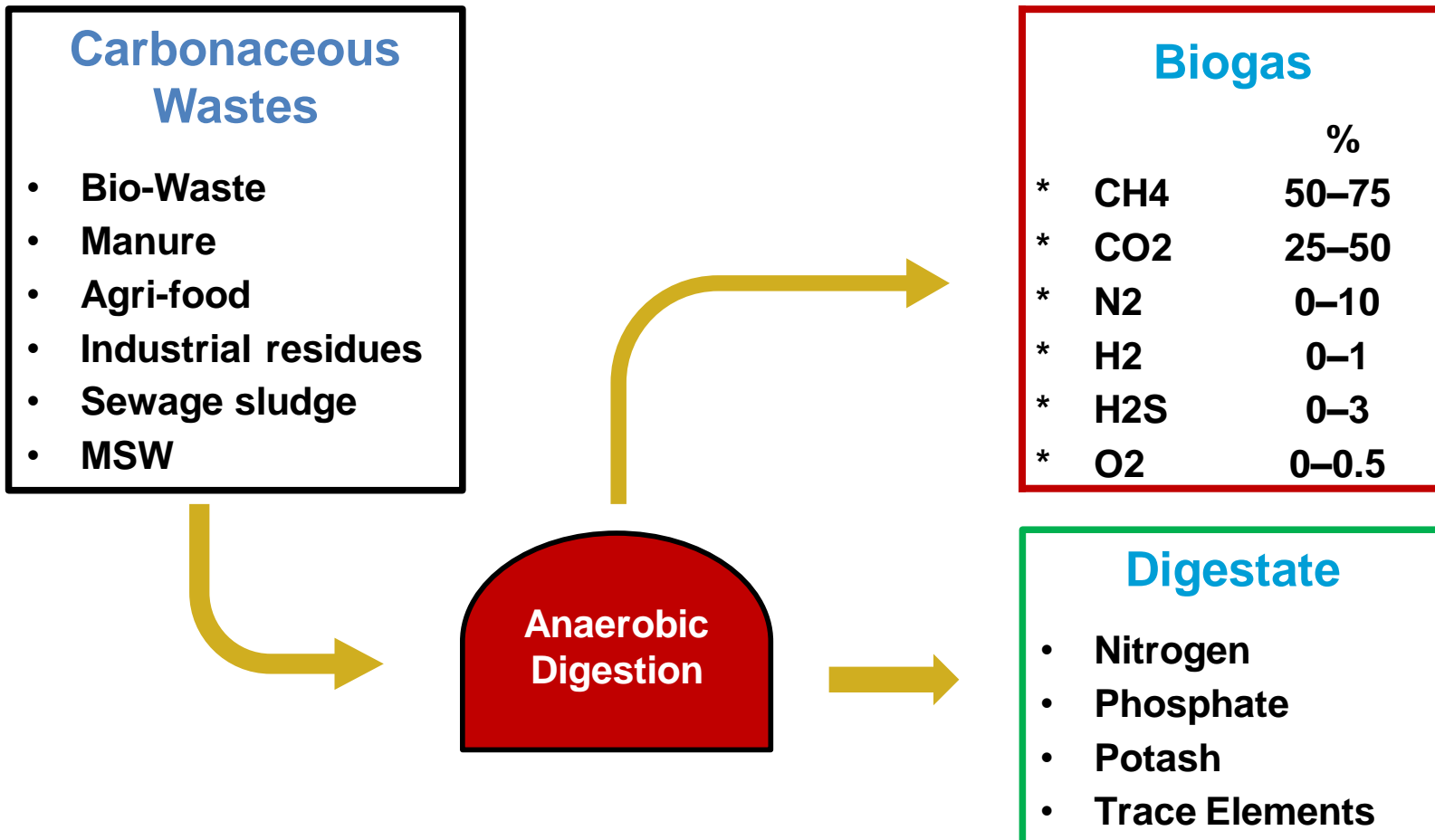


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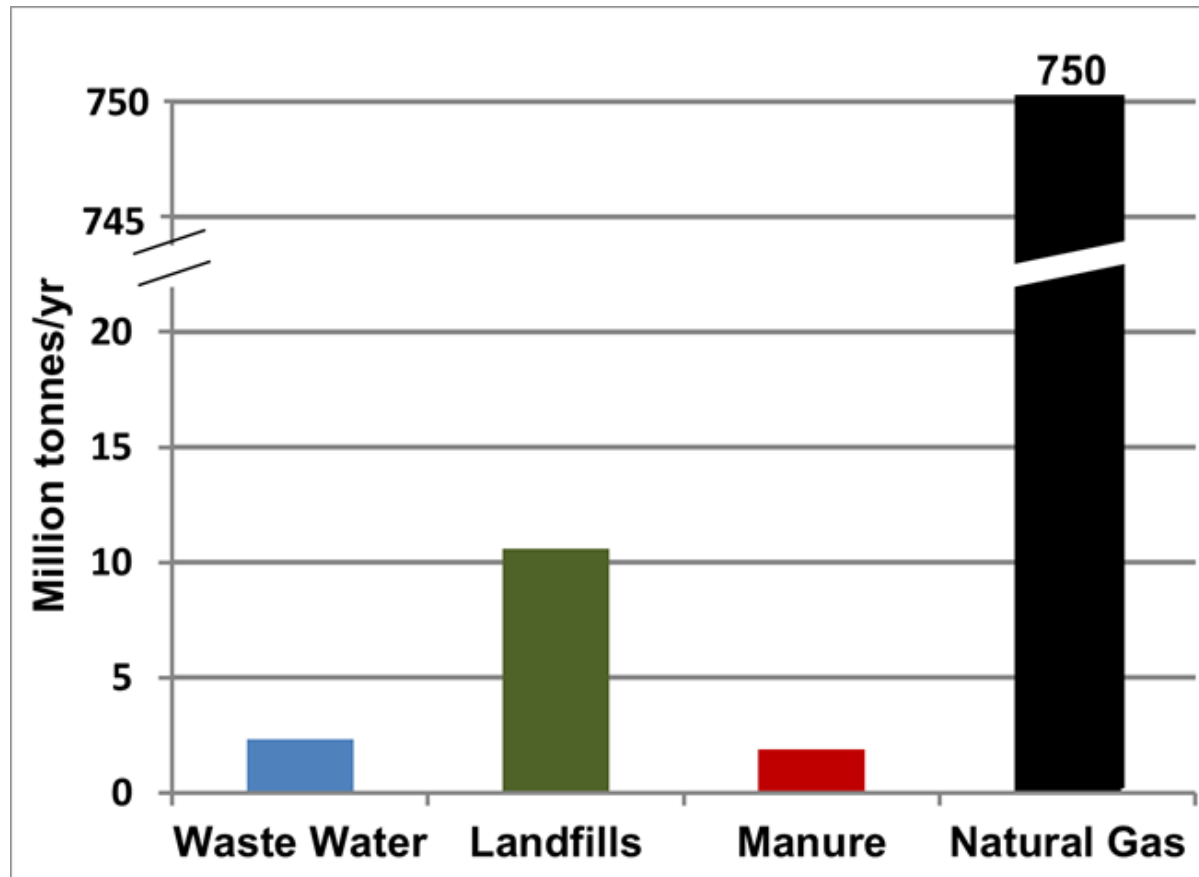
Biogas Conversion

- **Biogas – what, how much, where, why**
- **What it's good for**
- **Bio-methane**
- **What to do with it**
- **Key Players**
- **Conclusions**

What is Biogas?



How Much Biogas?



Where? Landfill Gas (EPA 2013)



LFG Energy Projects and Candidate Landfills



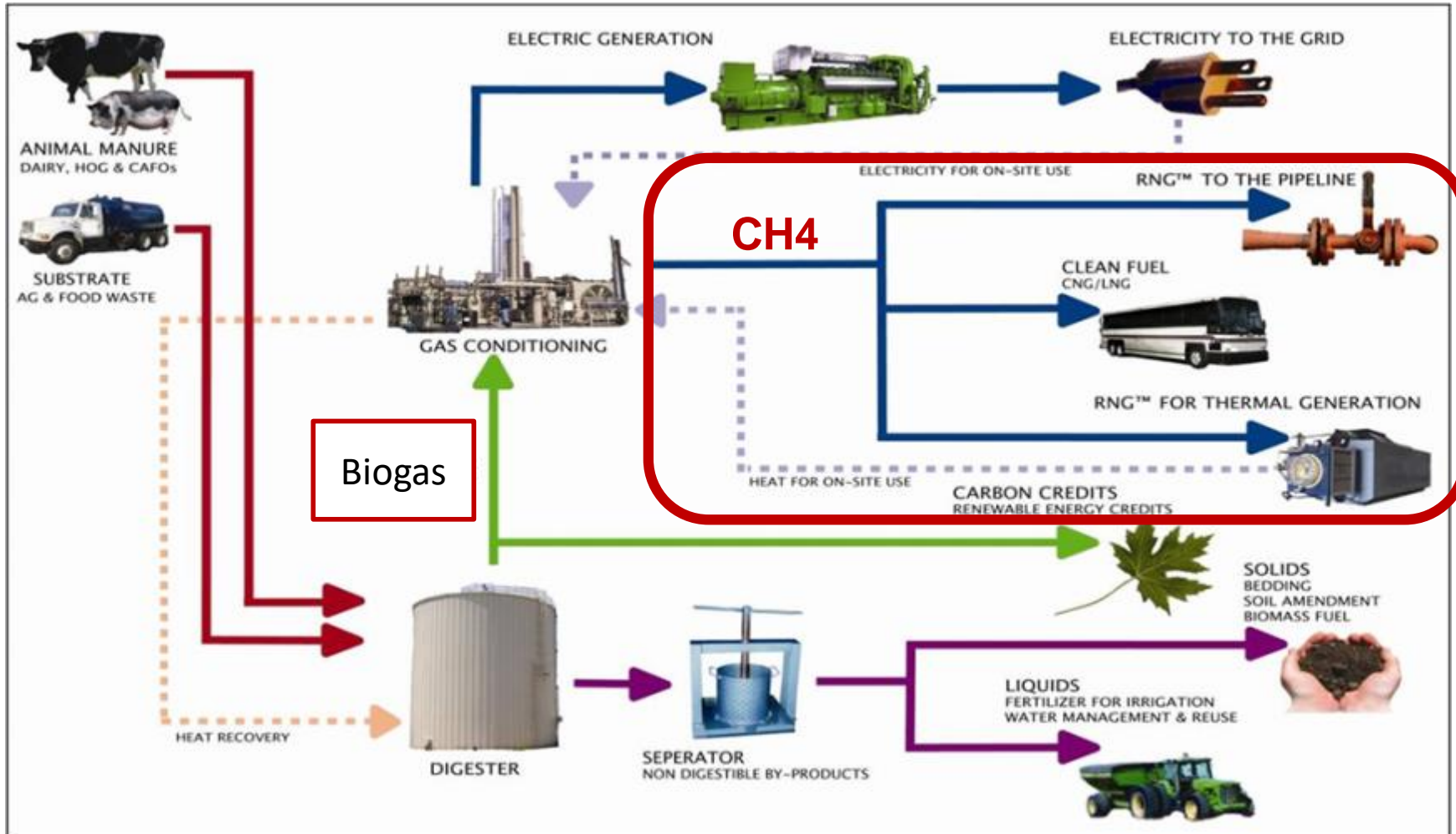
	Exist	Pot'l
Sites	621	450
MW	1,978	850
MMSCFD	311	470

These data are from LMOP's database as of July 16, 2013.

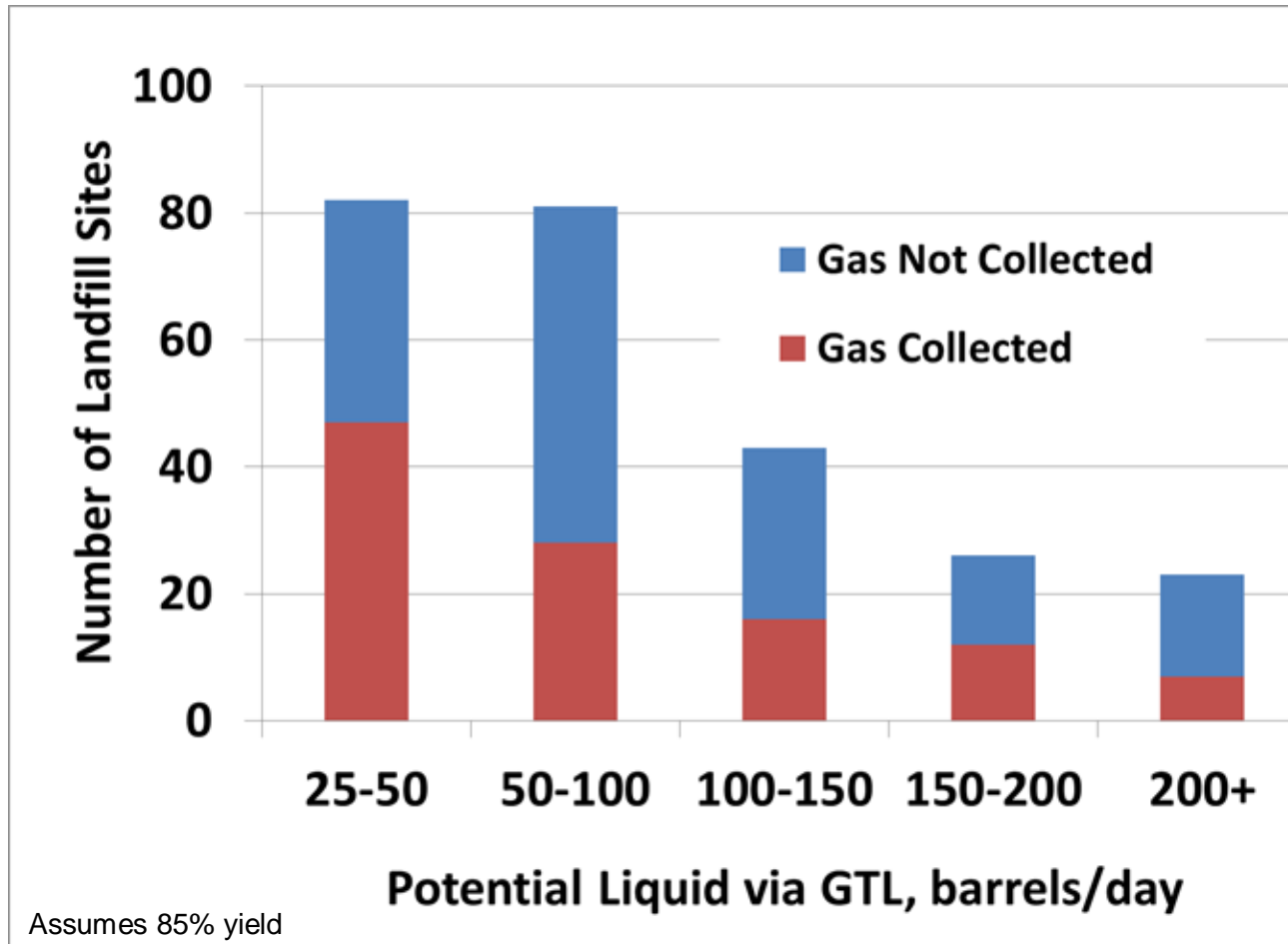
Why Biogas?

- **Made from waste products**
- **Low GHG emissions footprint**
- **Broad availability (landfills, farms, waste treatment plants)**
- **Does not compete with food supply**
- **Renewable fuel or chemicals production**
- **Relatively low cost form of renewable energy**
- **Can add to existing natural gas pipeline infrastructure**
- **Is a qualified feedstock for obtaining renewable biofuel subsidies – CNG, LNG, or GTL**

What's It Good For?



What Scale are the Landfill Gas Resources?



What to Do With It?

(Bio) Methane Upgrading

- **Direct Conversion**

- Oxidation



Methanol / Formaldehyde

- Oxidative coupling



Ethylene / Ethane

- Methanotrophic Bacteria



Feed, Fuel, Nutraceuticals

- **Indirect Conversion – Gas-to-Liquids**

- Steam Reforming

- Autothermal Reforming

- Biomass Gasification



Syngas



Methanol

MTG (gasoline)

Jet Fuel

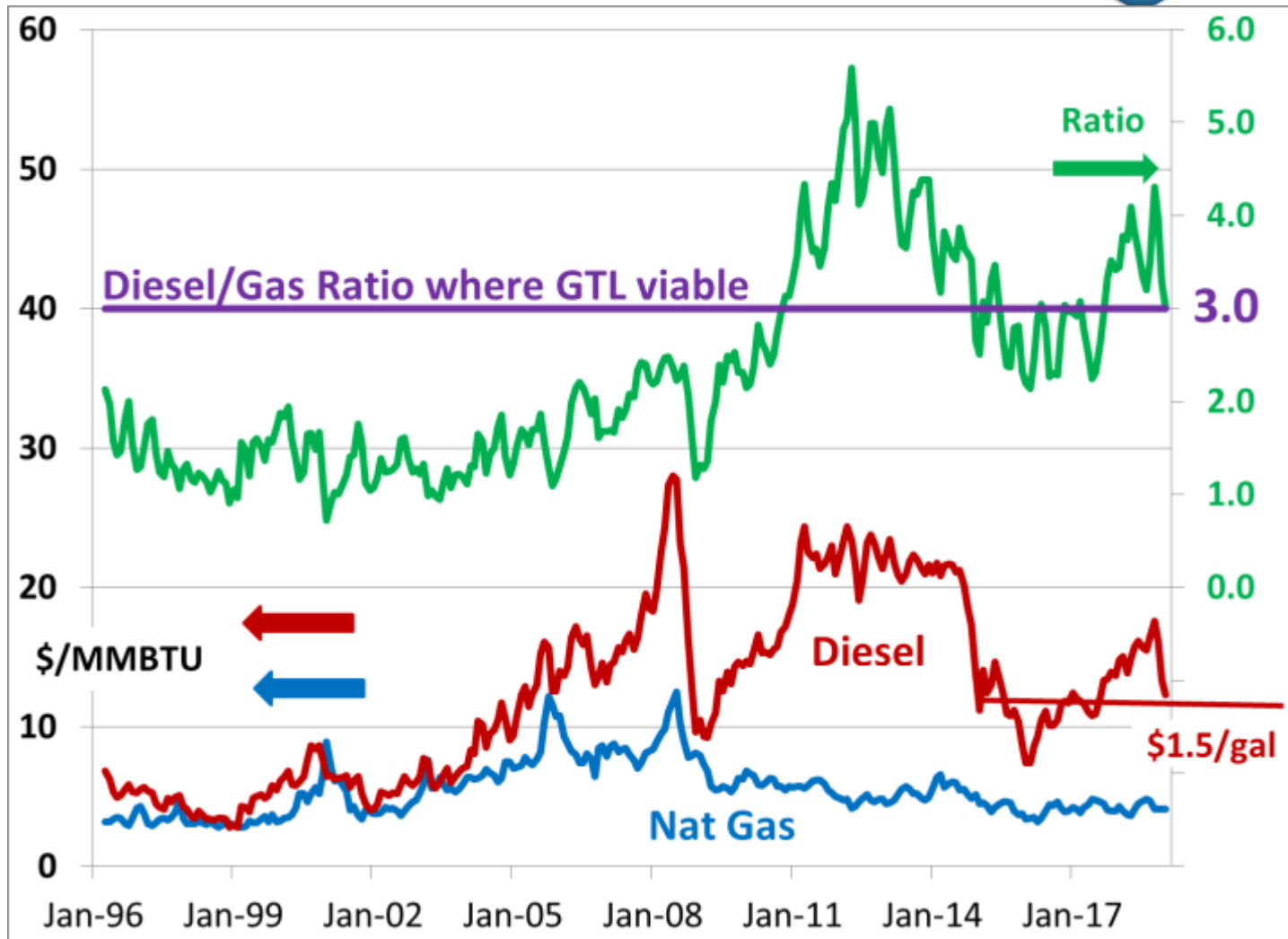
Diesel

Waxes

Acetic Acid

Hydrogen

Economic Viability of Gas-to-Liquids



Biogas Upgrading – The Players



Thermochemical

- Velocys
- CompactGTL
- INFRA
- Greyrock
- Gas Techno
- Siluria
- Oberon
- Primus Green Energy
- Emerging Fuels Technology
- Fulcrum Bioenergy
- BgtL-LLC

Biochemical

- LanzaTech
- Calysta
- Synata Bio (Coskata)
- Natureworks
- Unibio

Conclusions

- **Biogas is produced on small scale, scattered throughout the world**
- **Environmental concerns drive most biogas recovery and utilization installations**
 - MSW, Farm waste, etc.
- **Higher diesel and low gas prices enable economically viable GTL**
- **Reducing biogas cost and focusing on higher value niches is key to competing with natural gas**

Biogas Studies Available



- Comprehensive, critical, up-to-date analyses of all aspects of Biogas industry
- Literature, patents, reports, presentations, annual reports evaluated
- Key technologies, companies, and economics assessed
- Authoritative, experienced authors – industry and academic
- <https://lee-enterprises.com>
- 501-833-8511



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