

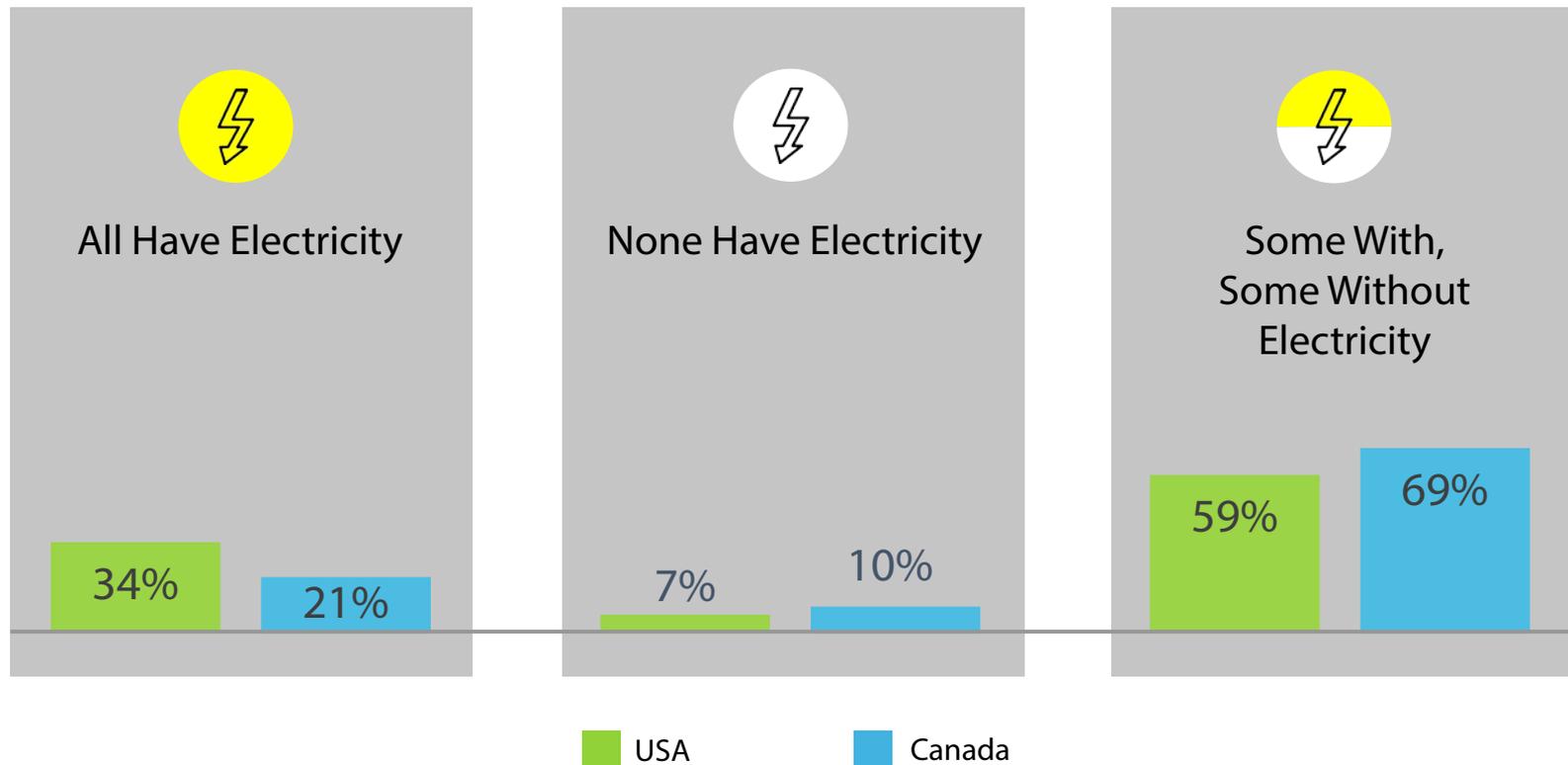
Mothusi Pahl & Larry Hjalmarson
Presented to: Natural Gas Star
Annual Implementation Workshop
2015.11.18



On-Site Power:
New Options for
Wellhead
& Gathering Compression

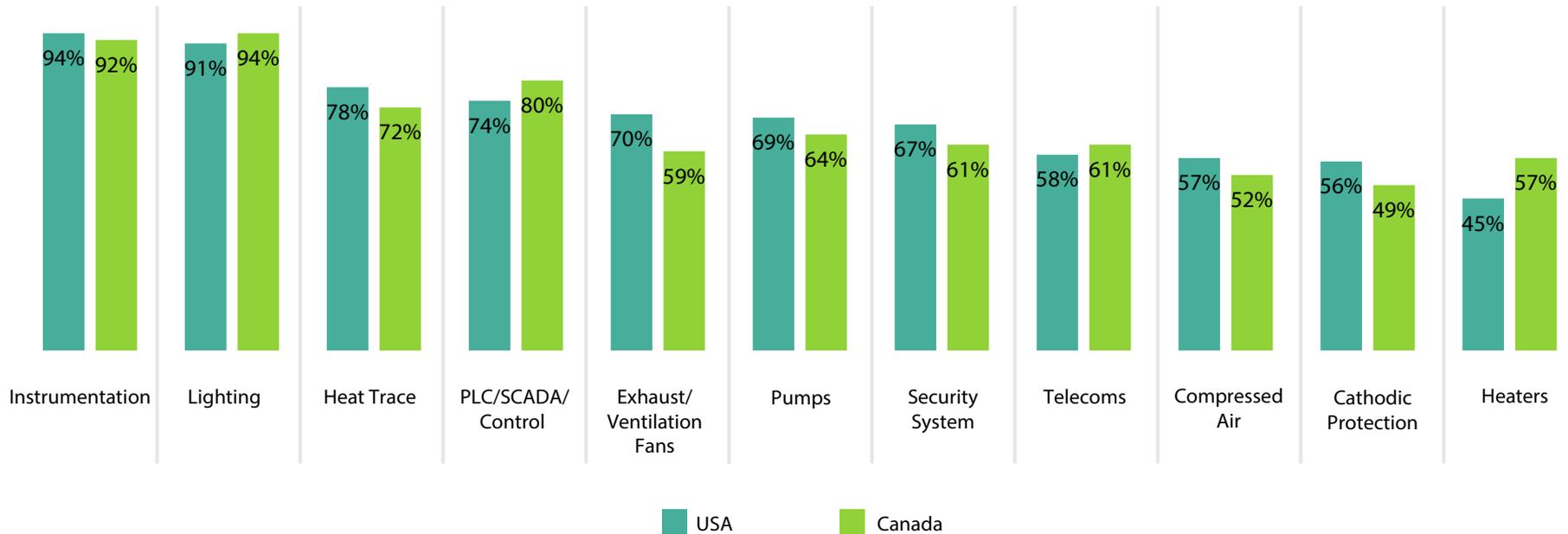
1. Survey
2. Electrical loads
3. New technologies
4. Applications
5. Midstream priorities
6. Field results & customer feedback

Electricity at sites – by company



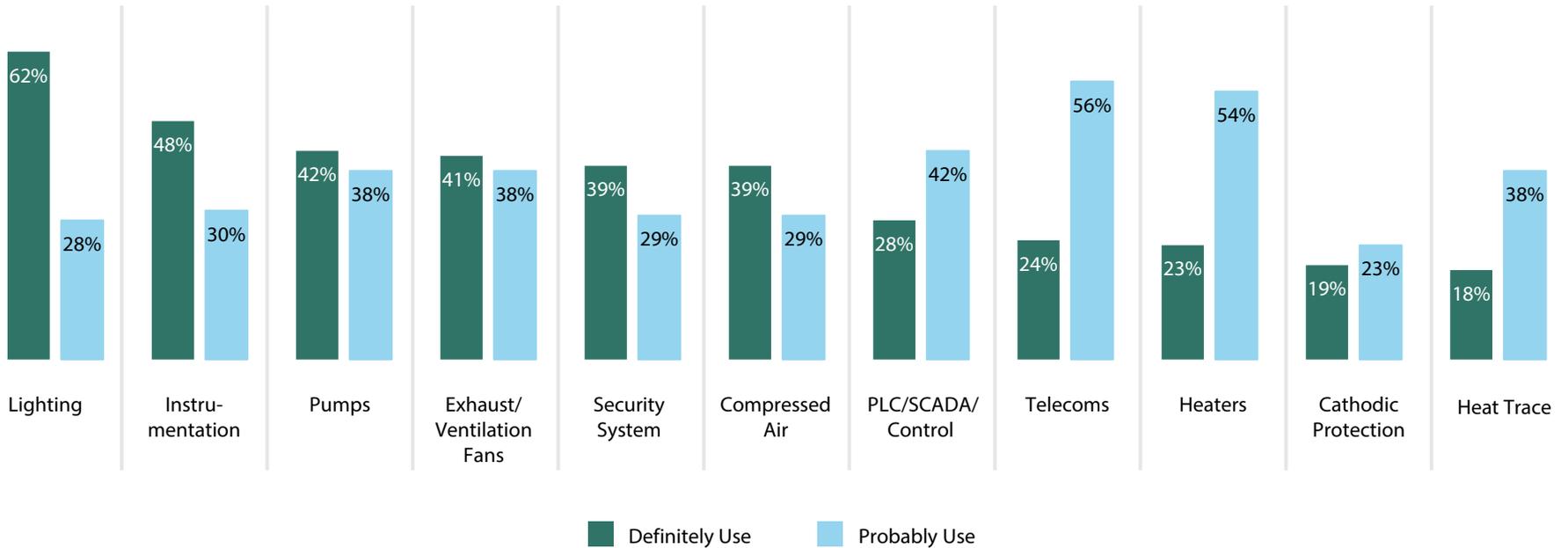
Gathering Line Compressor Stations

Grid Connected: Prevalence of Electrical Loads



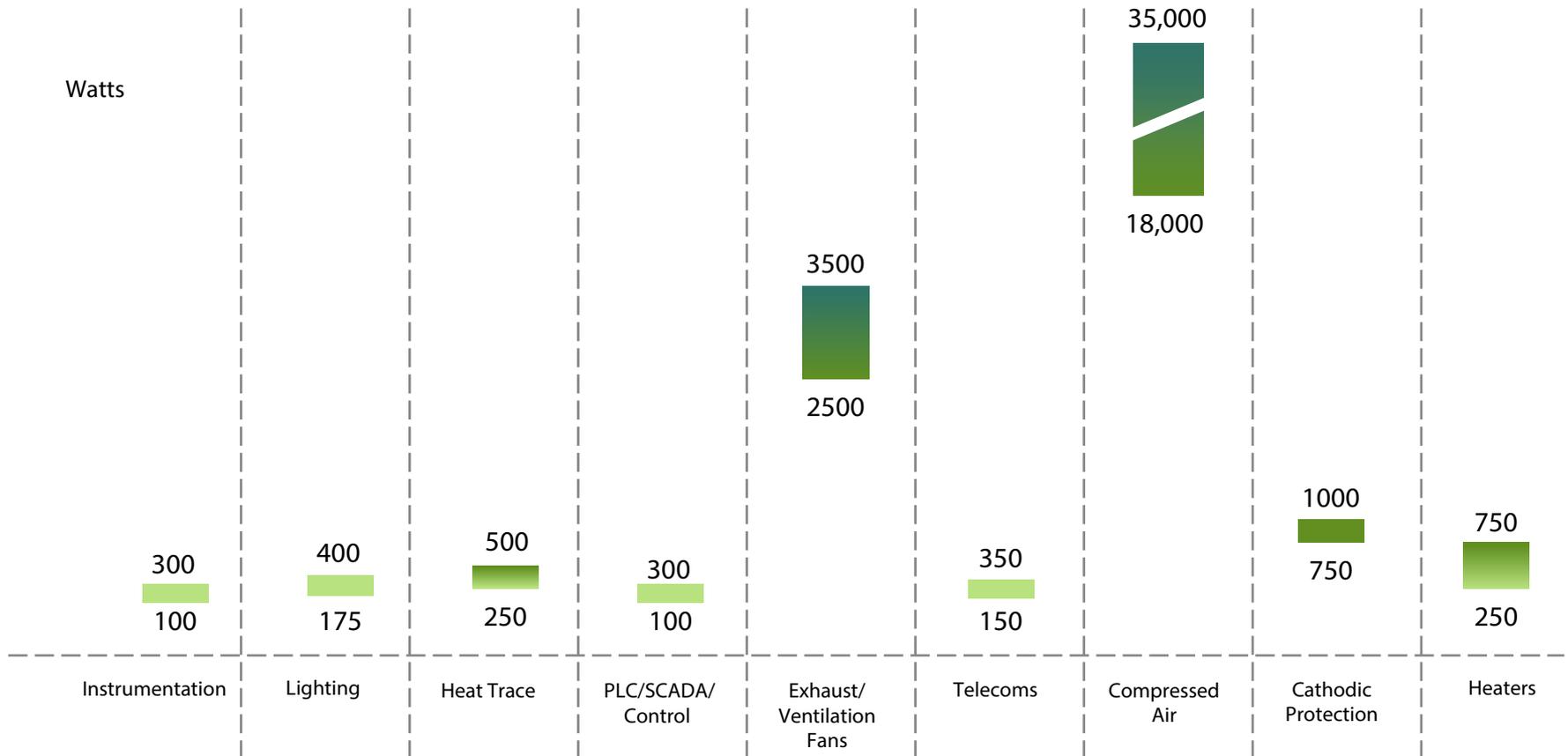
Gathering Line Compressor Stations

“If I had Electricity...” - Wish List

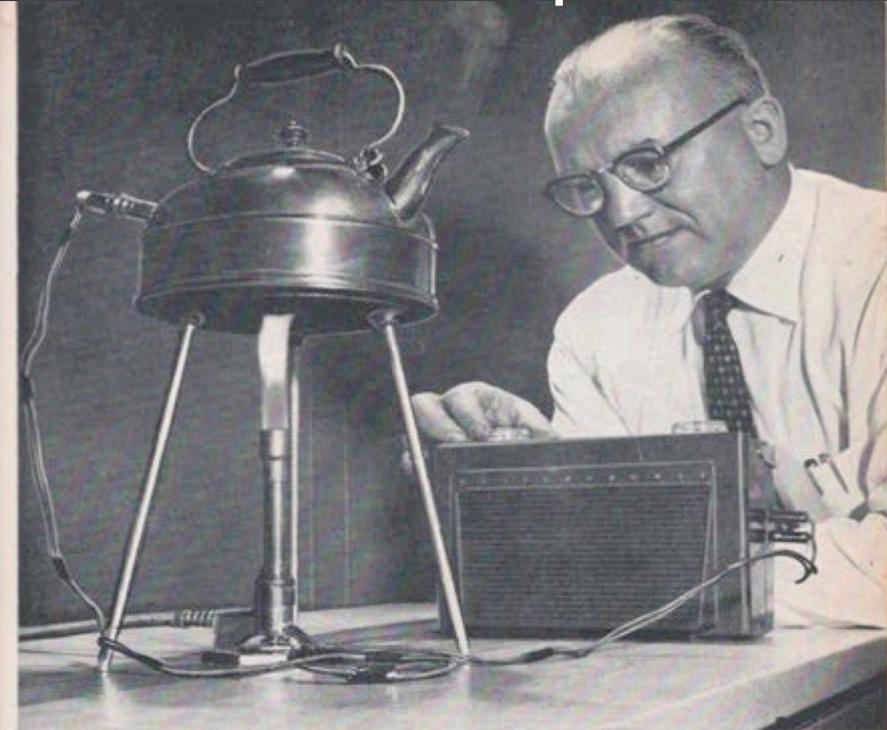


Sites ON the Grid: Equipment Load

Average Load Range for Common Gathering Equipment



Power Options?



Using materials which change heat directly into electricity, this thermoelectric teakettle powers radio

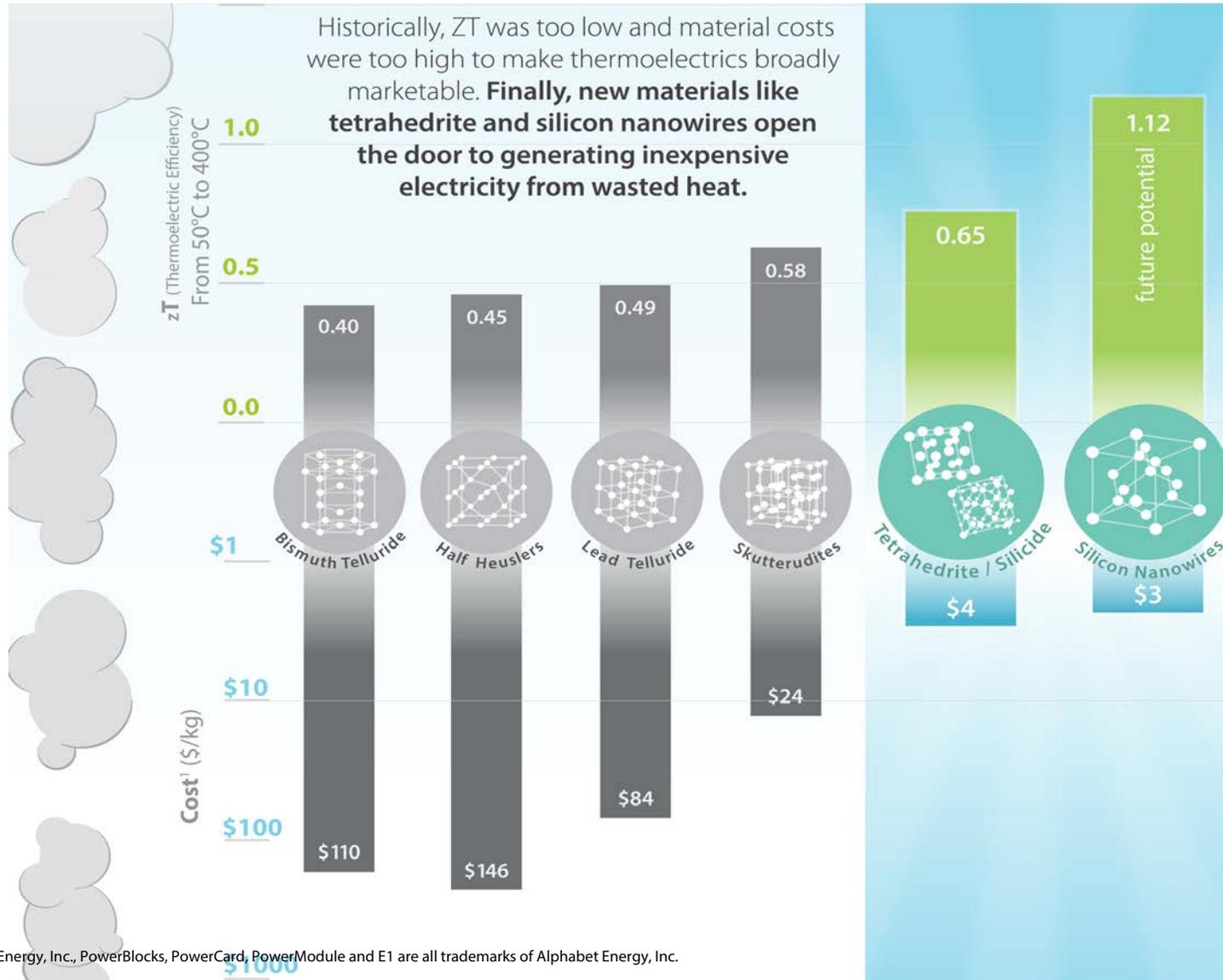
IN THE WESTINGHOUSE Research Laboratories at Pittsburgh I saw an old-fashioned copper teakettle bubbling away over a gas burner while waltz music came from a radio beside it. A homey scene, but deceptive, for unless hundreds of scientists and engineers throughout the world turn out to be wrong, it was a symbol of future power as exciting in its implications as another kettle which stirred the imagination of a boy named James Watt two centuries ago. A cable running from the kettle to the radio furnished its electric power—power produced by the same flame that boiled the water. In the base of the kettle was a small pioneer “thermoelectric generator” which converts heat directly into electric current, with no intermediate machinery.

Watt's teakettle grew up to be a steam

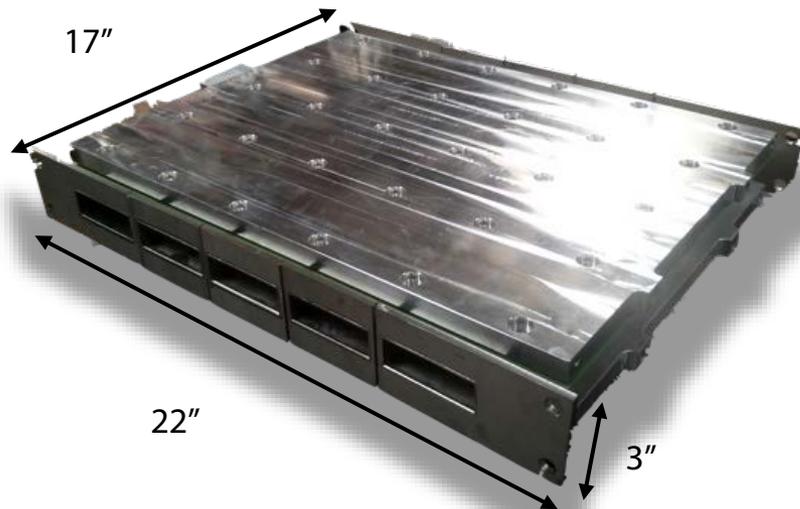
*Today's Alchemist is
Opening a New World*

**ELECTRICITY
DIRECT FROM
HEAT**

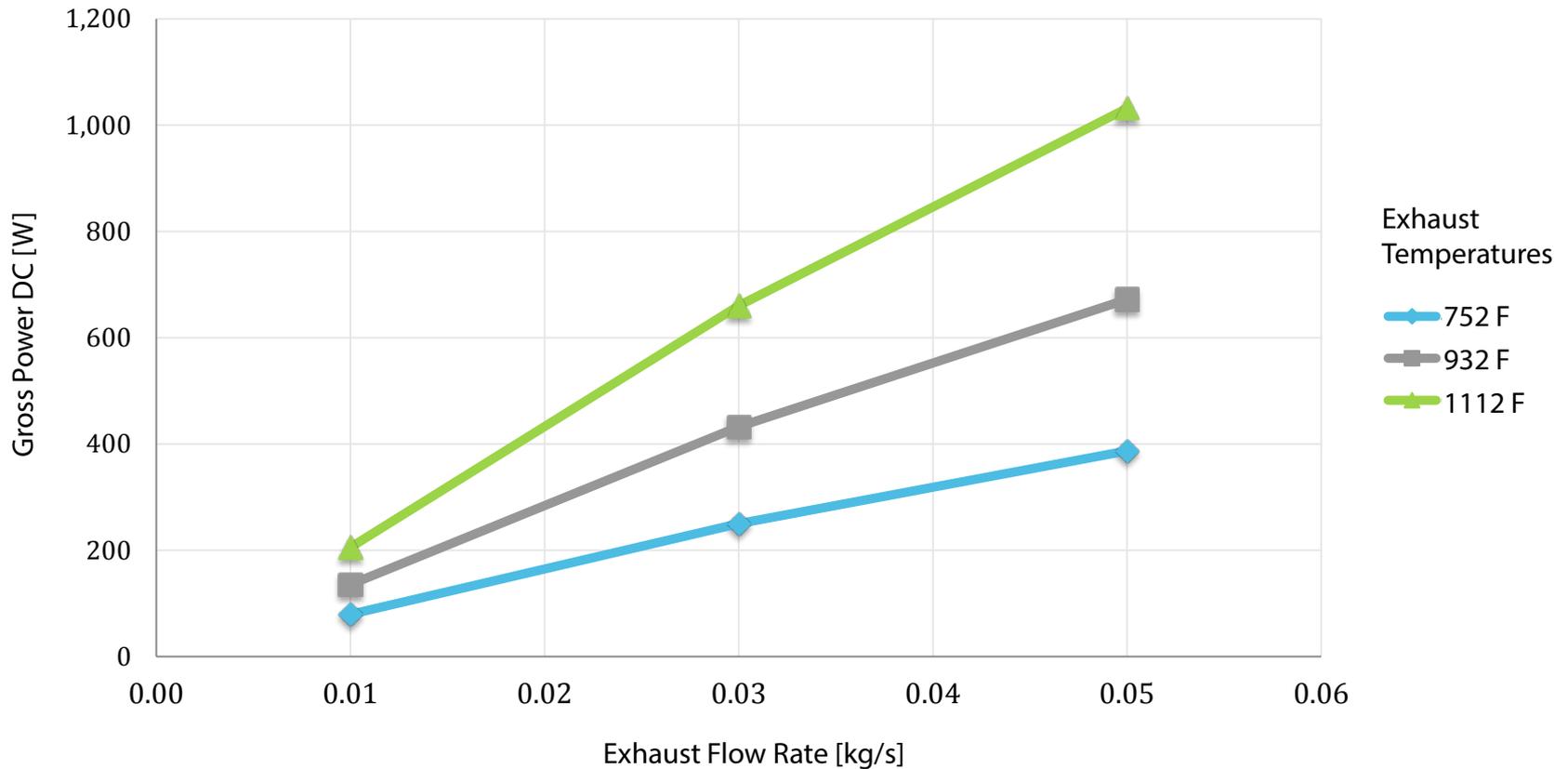
Thermoelectrics Today



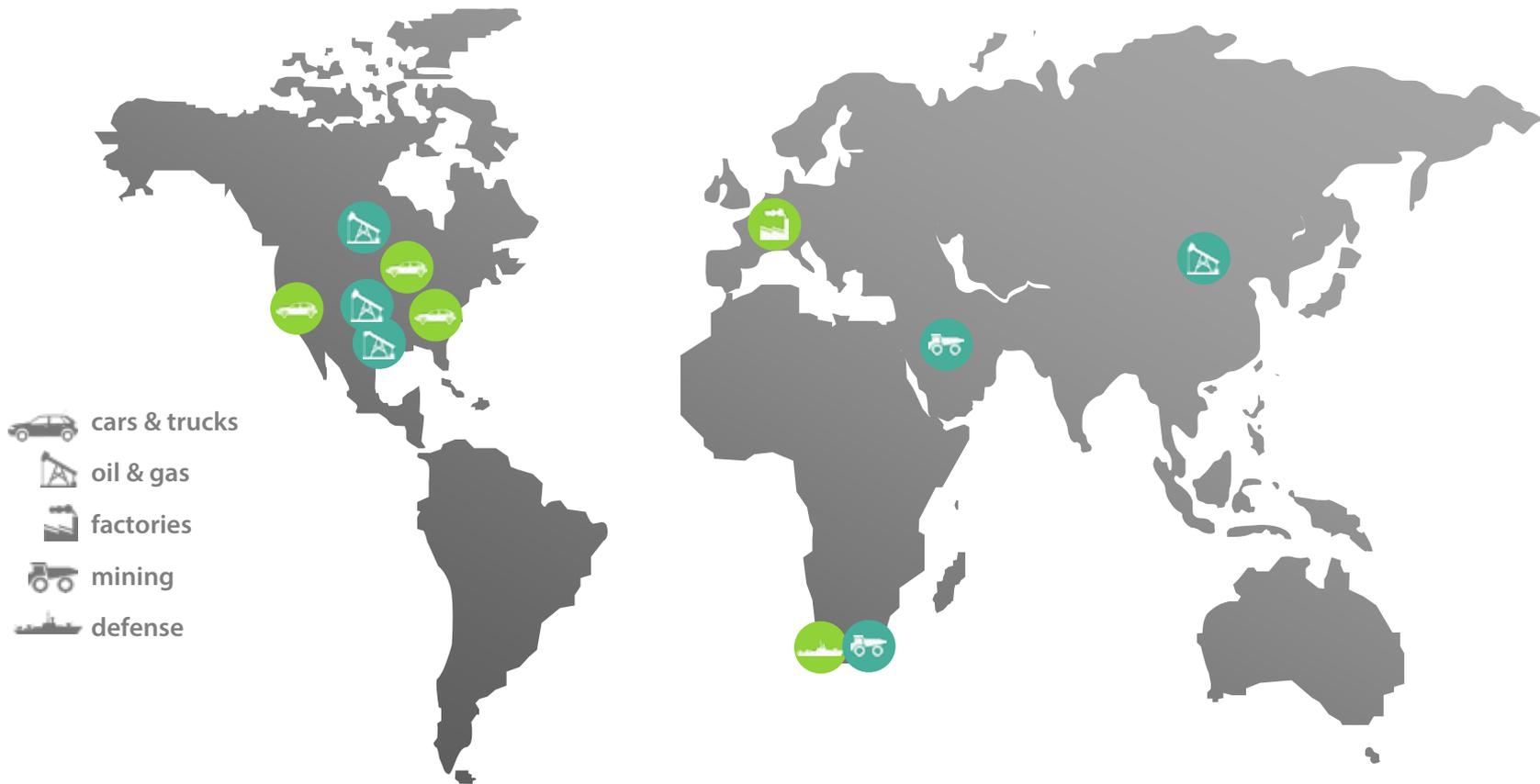
Alphabet Energy integrates PowerCards™ into interchangeable thermoelectric packages



PowerModule™ Performance



World-Class Customers



E1™ Prototype



Location: Alberta, Canada



Customer: E&P thru Midstream



Company Profile: 270,000+ barrels of oil /
equivalent per day

E1™ Generation 2



Location: Shaanxi province, China



Customer: Exploration & Production



Company Profile: 1,300,000+ barrels of oil /
equivalent per day

E1™ Generation 3



Location: Eagle Ford, Texas



Customer: E&P thru Midstream



Company profile: 900 Mcf of gas per day

E1™ Generation 4

Q1 - 2016



Location: Fayetteville Shale, Arkansas

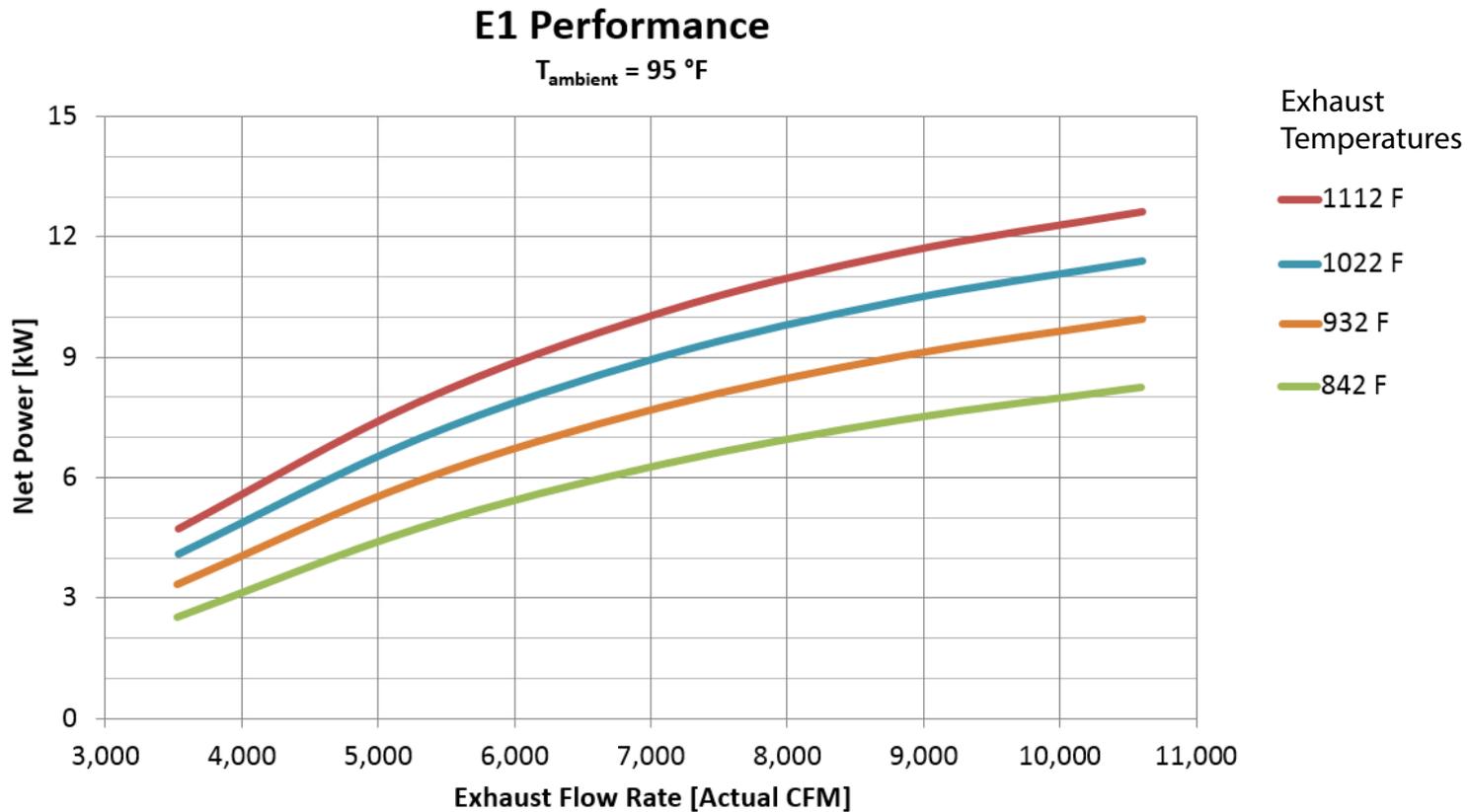


Customer: E&P thru Midstream

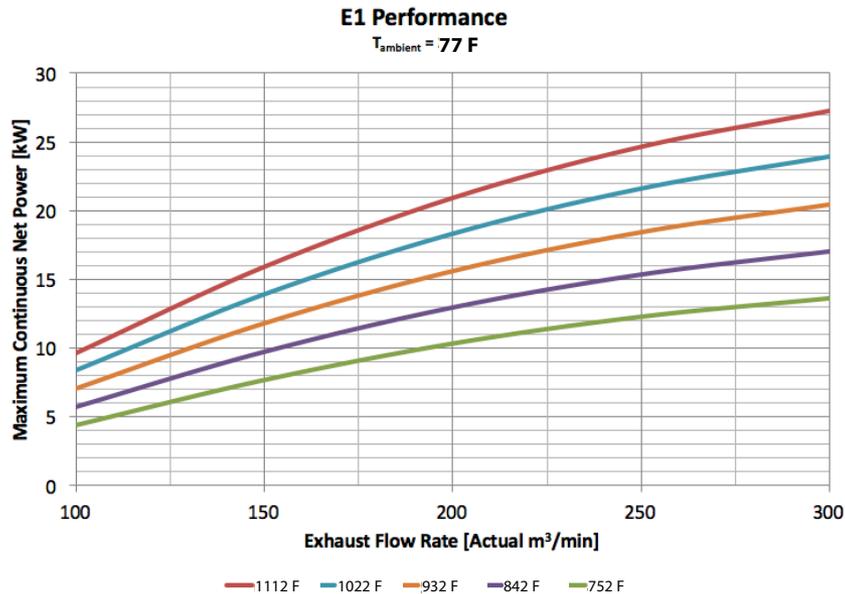


Company profile: 2,000 Mcf of gas per day

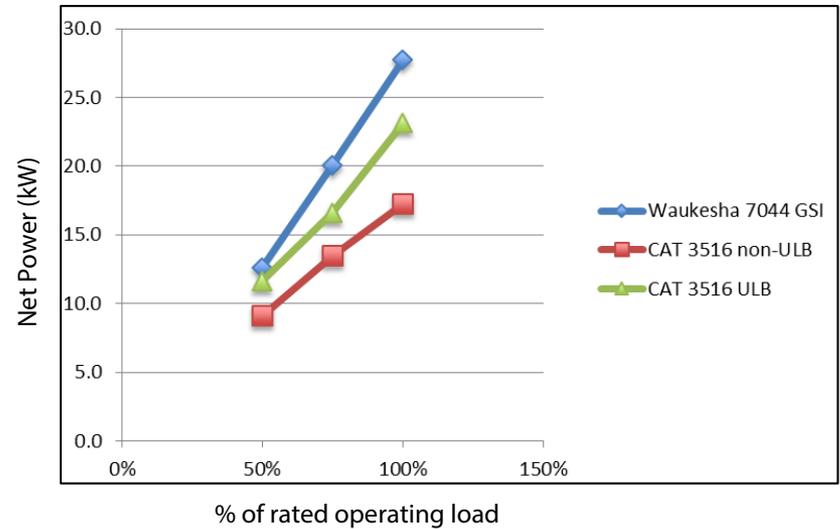
E1™ Eagle Ford Performance Data



By Flow Rate



By Engine



Fully Installed: Eagle Ford



Targets & Performance

CATERPILLAR®

CAT G3516

CAT G3516 B

CAT G3516 ULB

CAT G3516 TALE

CAT G3606

CAT G3608

CAT G3612



Waukesha L5794GSI

Waukesha L7042GL

Waukesha L7042GSI

Waukesha L7044GSI

Waukesha 9394



- AC
- 3-phase
- Up to 40 amps @ 480 volts
- Voltage options
 - 120/208
 - 120/240
 - 277/480



Reliability & Bottom-line Improvement

- Limit exposure to grid & generator outages
- Reduce electrical spend
- Gas equity improvement



Site Safety & Environment

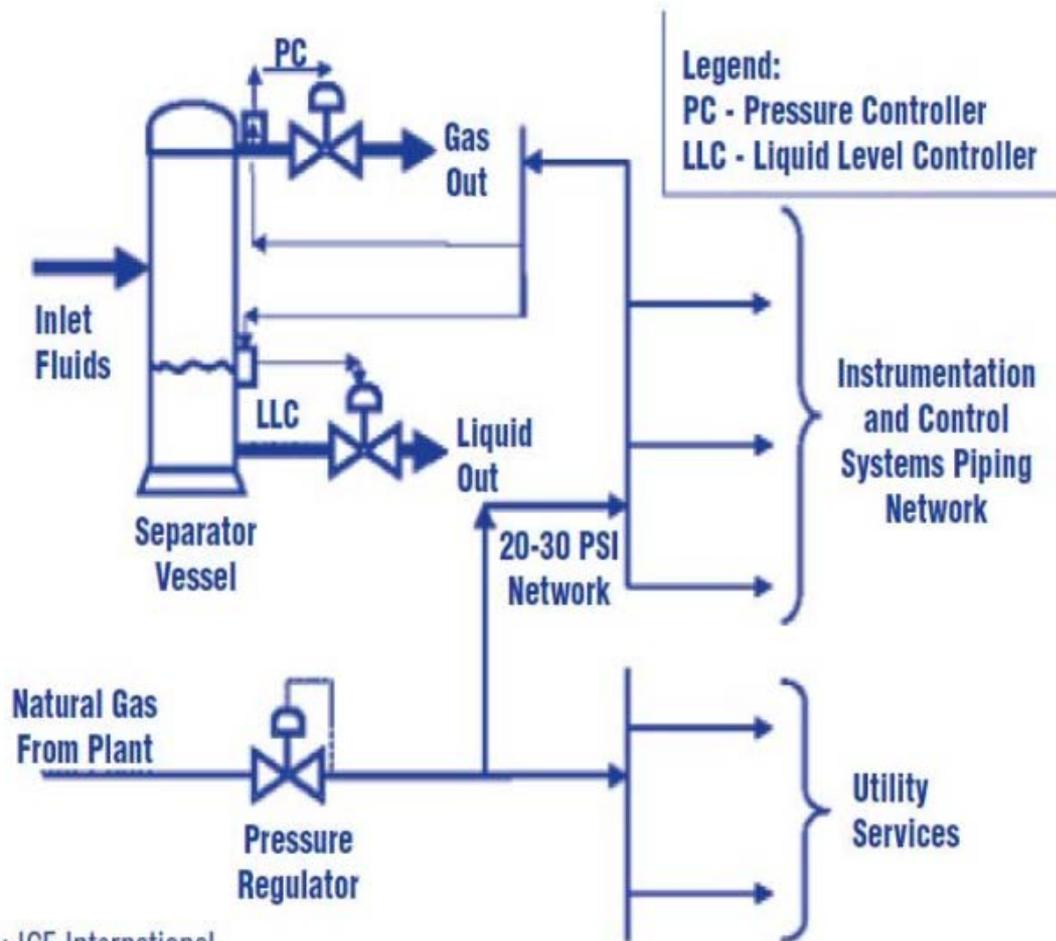
- Enable transition away from gas pneumatics
- Eliminate fugitive emissions
- Reduce fire risk



Good Neighbor

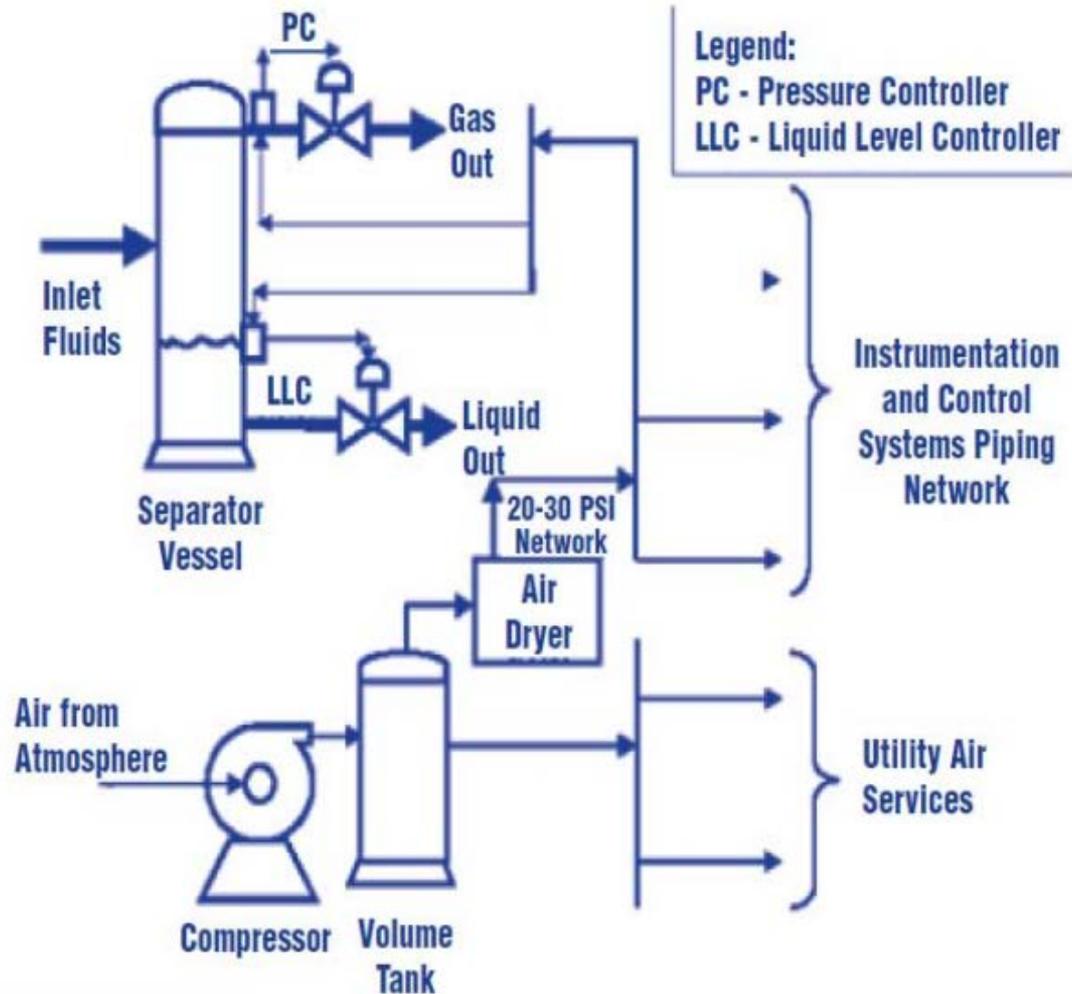
- No generator noise
- No new emissions permit
- Reduce fugitive emissions
- No power line construction

Instrument & Utility Gas



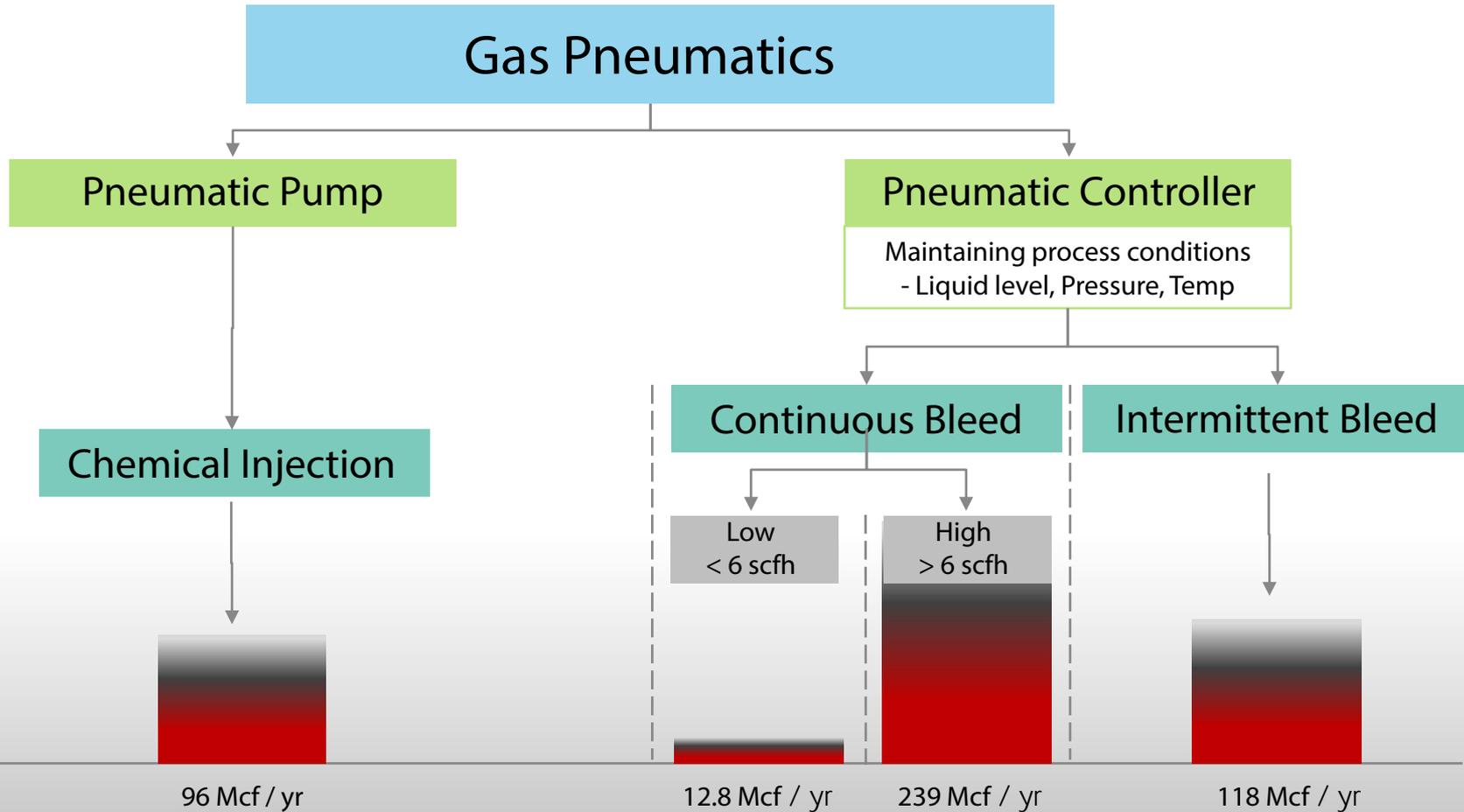
Source: ICF International

Instrument & Utility Air

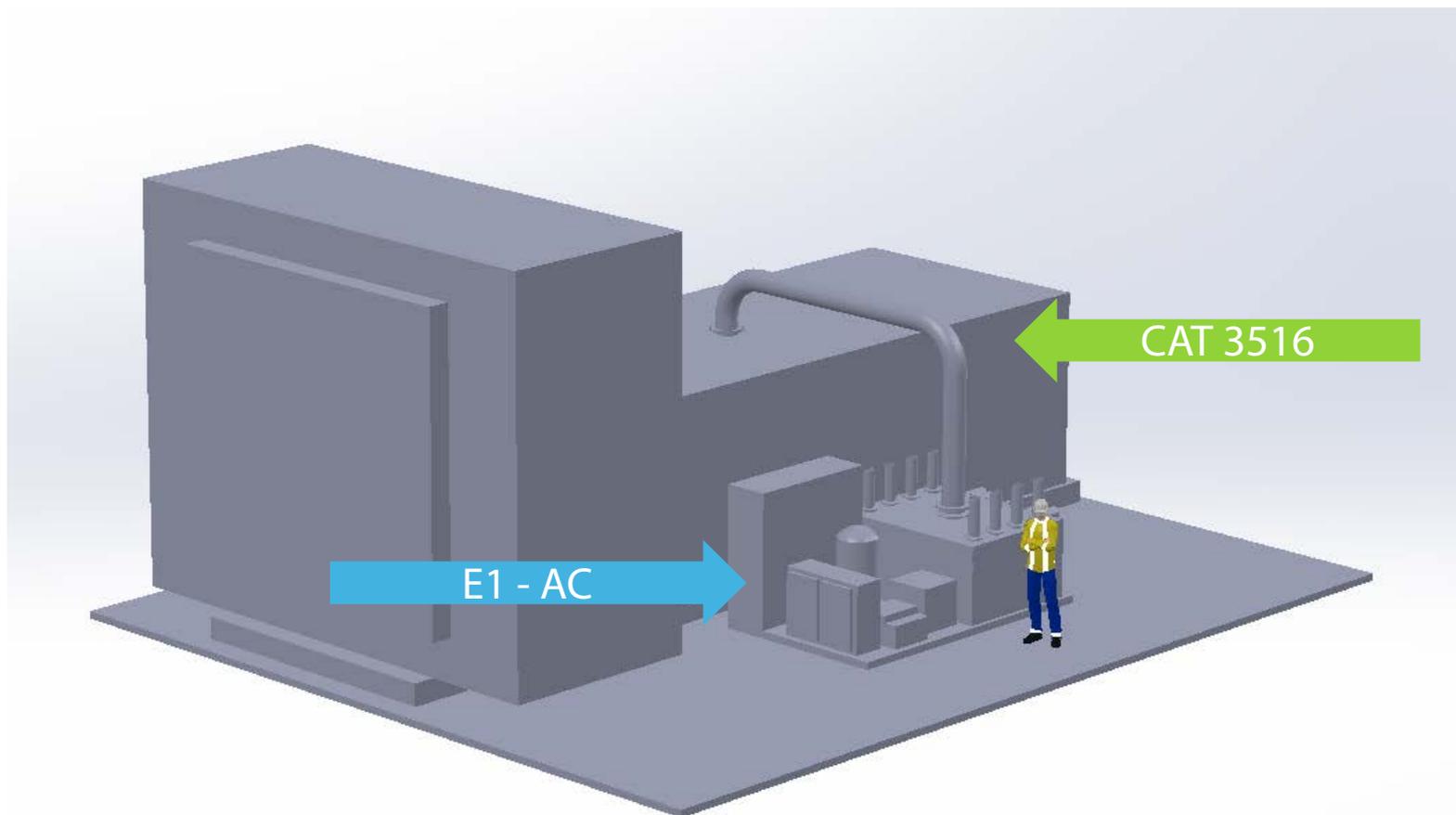


Source: ICF International

Fugitive Emissions



New Developments: E1-AC



Single skid package: E1 + air compressor + dehydration unit.
Enables the replacement of gas pneumatics at wellheads & compressor stations.

Replaces flares & incinerators

- Meets OOOO
- Eliminates need for on site diesel & gas generators
- Lowers site emissions profile

Enclosed Combustor / Generator

Size	Dimensions (OD, height) [ft]	Maximum Heat Release [MMBtu/hr]	Power/Output [kW]
Small	2.5 x 15	1.8	8
Large	4 x 30	10.0	39



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Results from Customers



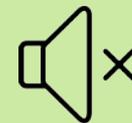
Performance

Over 6 years of accelerated engine runtime & service events with no degradation in performance



Pressure Drop

E1™ complies with all major engine manufacturer warranty specs & back pressure limits



Sound Attenuation

E1™ exhaust insertion loss:
25dBA,
standard “commercial grade”
silencer = 14-20dBA

