

## Report Back:

***Community, Apartment, Small Commercial:  
“Product Specs” in 6-10 years and beyond***

June 1, 2011

# ARPA-E provided us a strawman for community, apartment, small commercial, 10% adoption in 6-10 years



## Sample strawman table (for community or small commercial):

<u>Category</u>	<u>ARPA-E's proposed</u>	<u>Rationale</u>
System rating	200-500 kWe	
Electrical efficiency (@ ≥50% kW rating)	≥60%	
Part-load efficiency	≥75% of max efficiency	
Emissions	EPA, CARB tier??	
Cost	First cost: \$xxk installed, or \$1000/kW or LCOE: \$0.15/kWh over 7 years	
Payback	2 – 3 yrs	
Unit volume @ price point	5,000	
Fuel type	NG, propane, biogas, fuel-flexible	
Maintenance frequency	Once per year, maintenance <8 hr, \$xxx	
Reliability	<1 unintentional outage per yr, <8 hrs 99.91%	
Lifetime	>60,000 hrs before major overhaul or replacement	
Electrical output type AC/DC, frequency	AC = 60Hz, 120v DC option??	
...and more...		

## Key Takeaways in common to the 3 groups



1. LCOE is the most important consideration;  
\$0.15 / kWh is too high for a 10% adoption target
2. Metrics cannot be considered independently,  
tradeoff flexibility is needed to meet LCOE target
3. Should we consider other ranges, below 200 kW  
or above 500 kW?

# LCOE is most important metric



\$0.15 / kWh too high compared to \$0.05-0.15 / kWh for conventional

- Group 1: \$0.10 / kWh, but disagreement on manufacturing learning curve (\$0.10 / kWh at 100<sup>th</sup> unit or 5000<sup>th</sup> unit)
- Group 2: \$0.09-0.12 / kWh,
- Group 3: too high, but not sure on final price

## Metrics are interrelated



Approach 1: ask experts where do each of these metrics need to be to possibly reach the LCOE target

- Clear tradeoffs between metrics to achieve LCOE
  - i.e. High efficiency and high capex vs low efficiency and low capex

Approach 2: create a functional model for LCOE, including some parameters fixed by ARPA-E and some metrics proposed by performers that reach the LCOE target

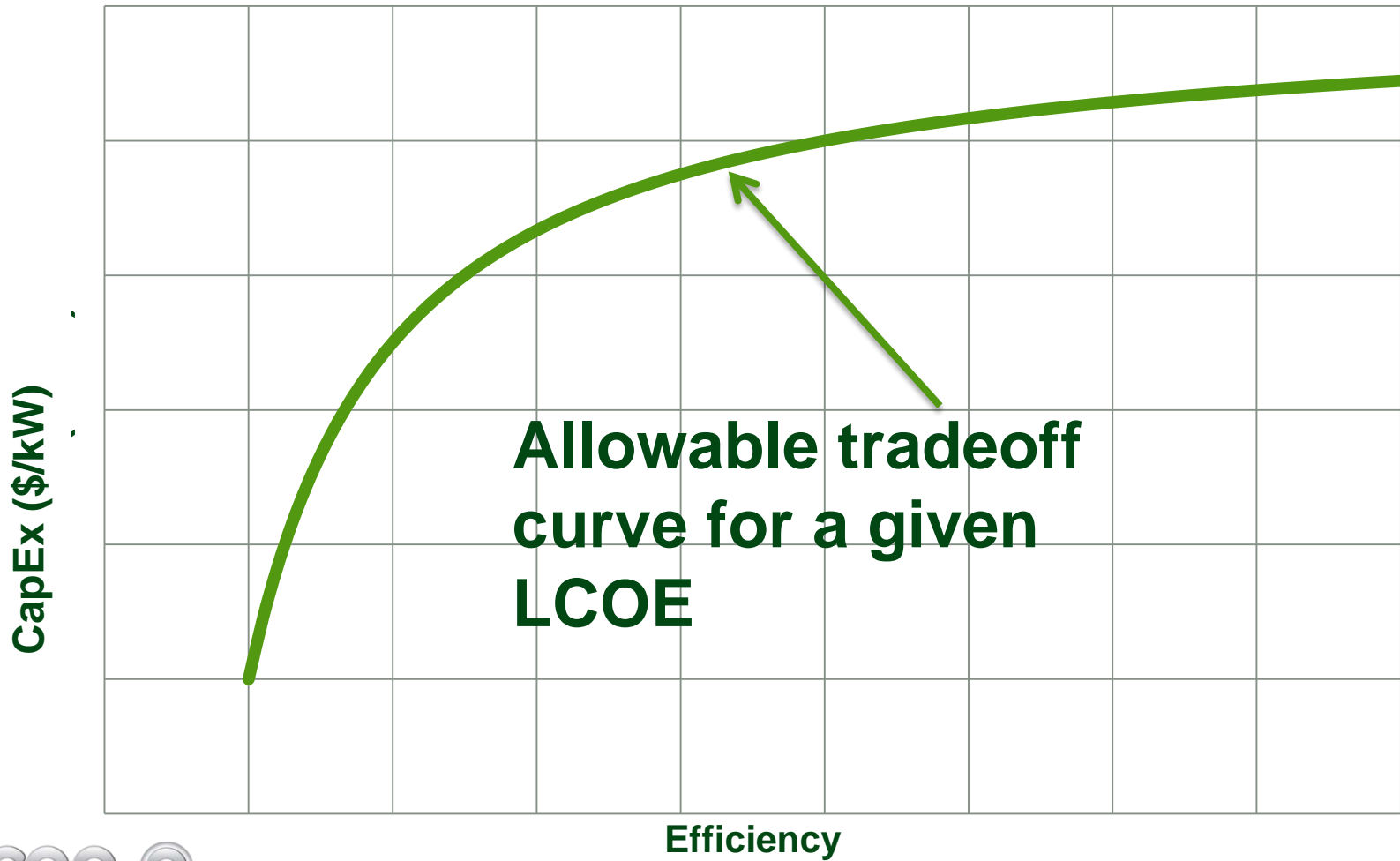
- ARPA-E parameters: natural gas price, load profile, financing parameters
- Applicant parameters: capex, opex, efficiency

# Functional LCOE metric model



- Group 1 proposes
  - Create a function LCOE with inputs of capex, opex, efficiency, etc. and allow applicant to use
- Group 2 proposes
  - Use a LCOE target to generate a metric curve of capex vs efficiency, set at a minimum allowable efficiency using emissions requirements

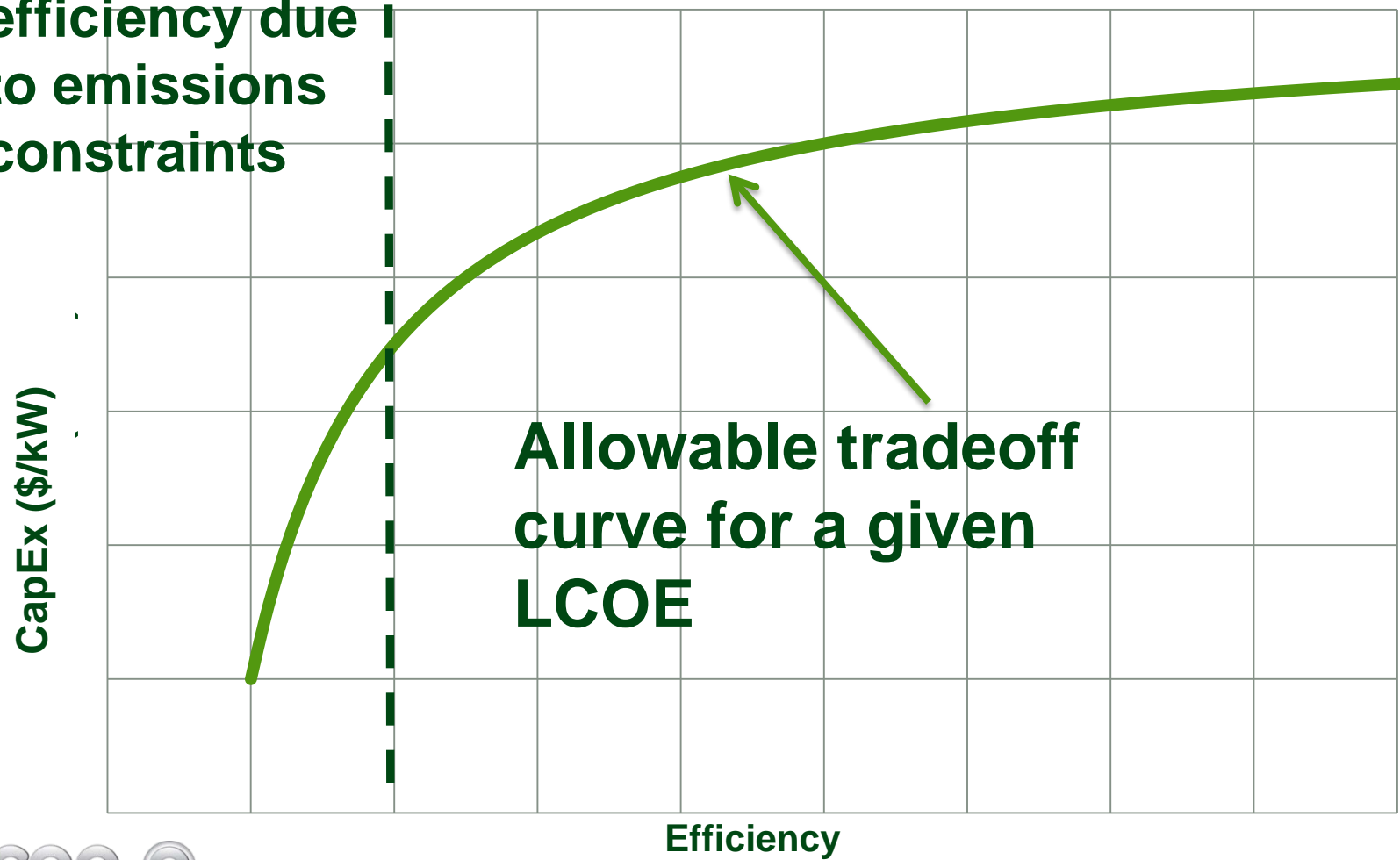
# Capex vs. Efficiency curve



To beat emission constraints, cost to efficiency ratio is initially very high



**Minimum efficiency due to emissions constraints**





# Should ARPA-E consider other power ranges?



- This would enable more adoption in community apartments and within the small commercial sector
- Group 1: add 50 kW to 200 kW
  - McDonald's is 150-300 kW
- Group 2: 10 kW to 200 kW
- Group 3: add 200 kW to 1 MW
  - Clusters of restaurants and stores
- Are these extra ranges needed to develop new technologies or are they needed to reach 10% market penetration?

# Prioritization of Metrics



## 1. LCOE

- a. Efficiency
- b. Capex + installation = installed cost
- c. Opex + maintenance
- d. Reliability
- e. Lifetime

## 2. Customer functional requirements

- a. Emissions
- b. Turndown ratio
- c. Noise
- d. Power Quality
- e. Temperature
- f. Footprint (20' shipping container)
- g. Part load efficiency

## Other issues mentioned



- Lifecycle issues: what happens to the unit after its lifetime; what components are decommissioned and recycled?
- Use of storage: divergence between groups on how important this was.

# We modified the ARPA-E strawman for community, apartment, small commercial, 10% adoption in 6-10 years



<u>Category</u>	<u>ARPA-E's proposed</u>	<u>Modifications</u>
System rating	200-500 kWe	<b>10 -1000 kW</b>
Electrical efficiency (@ ≥50% kW rating)	≥60%	<b>&gt; 55% for 50-200 kW Range</b>
Part-load efficiency	≥75% of max efficiency	<b>&gt;75%-90% at 50% load</b>
Emissions	EPA, CARB tier??	<b>EPA Tier 4 - CARB should be used</b>
Cost	First cost: \$xxk installed, or \$1000/kW or LCOE: \$0.15/kWh over 7 years	<b>Aim for \$0.10/kWh. Installed cost 600-1500\$/kW</b>
Payback	2 – 3 yrs	<b>&lt; 3 years</b>
Unit volume @ price point	5,000	<b>100-5000</b>
Fuel type	NG, propane, biogas, fuel-flexible	<b>Fuel flexible a bonus</b>
Maintenance frequency	Once per year, maintenance <8 hr, \$xxx	<b>Twice a year</b>
Reliability	<1 unintentional outage per yr, <8 hrs 99.91%	<b>95%-99%</b>
Lifetime	>60,000 hrs before major overhaul or replacement	<b>Hard metric, prime mover needs &gt; 44 000 hours. Some want longer.</b>
Electrical output type AC/DC, frequency	AC = 60Hz, 120v DC option??	<b>208, 480 V as well</b>
...and more...		<b>Noise, 60 dB at 10 m Temperature -40 F to 125 F Turndown Ratio &gt; 3</b>