



# Co-Optima: Low Greenhouse Gas Fuels and Properties

- Can we generate bio-blendstocks which have the potential to:
  - reduce greenhouse gas footprint,
  - while adding additional value by increasing engine efficiency?
- Can we define fuel properties such that any fuel from any source with those properties will behave the same in an engine?
- Can we identify candidates whose fuel behavior varies from petroleum-based fuels in useful ways?



Foundational biofuel chemistry-property relationships



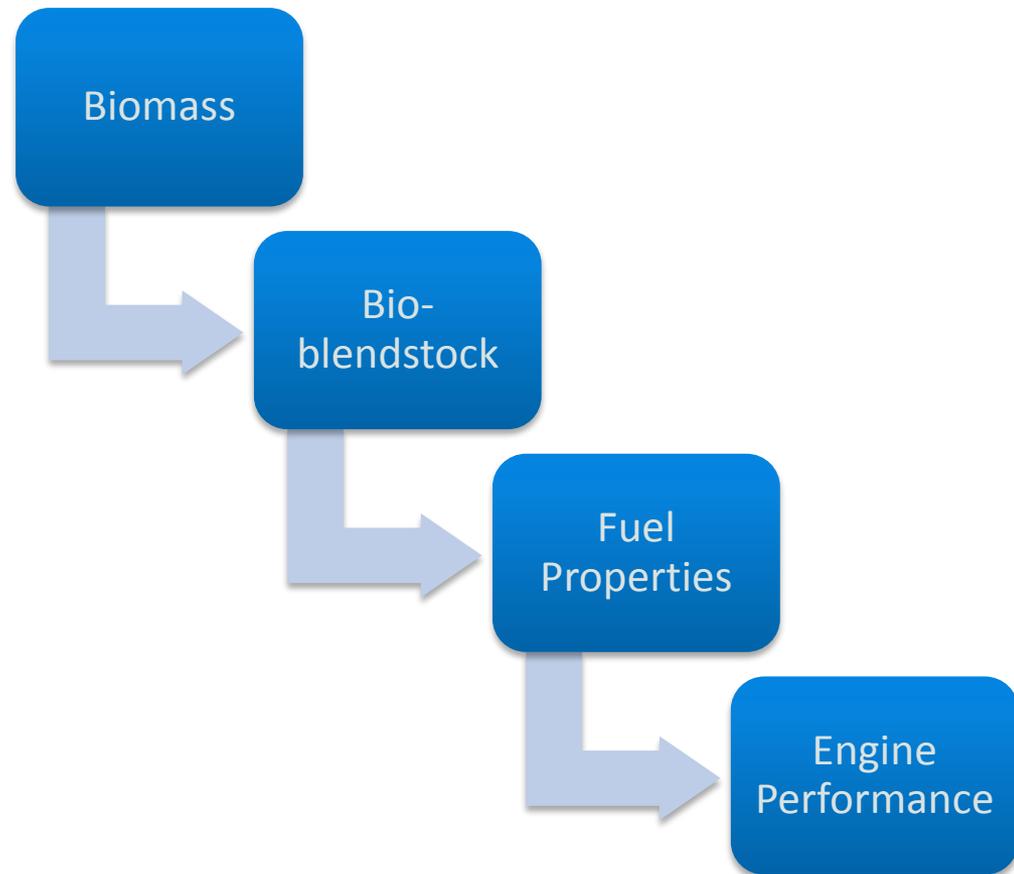
Provide scientific and technical basis for decision-making by market actors



Design criteria for new bio-blendstocks

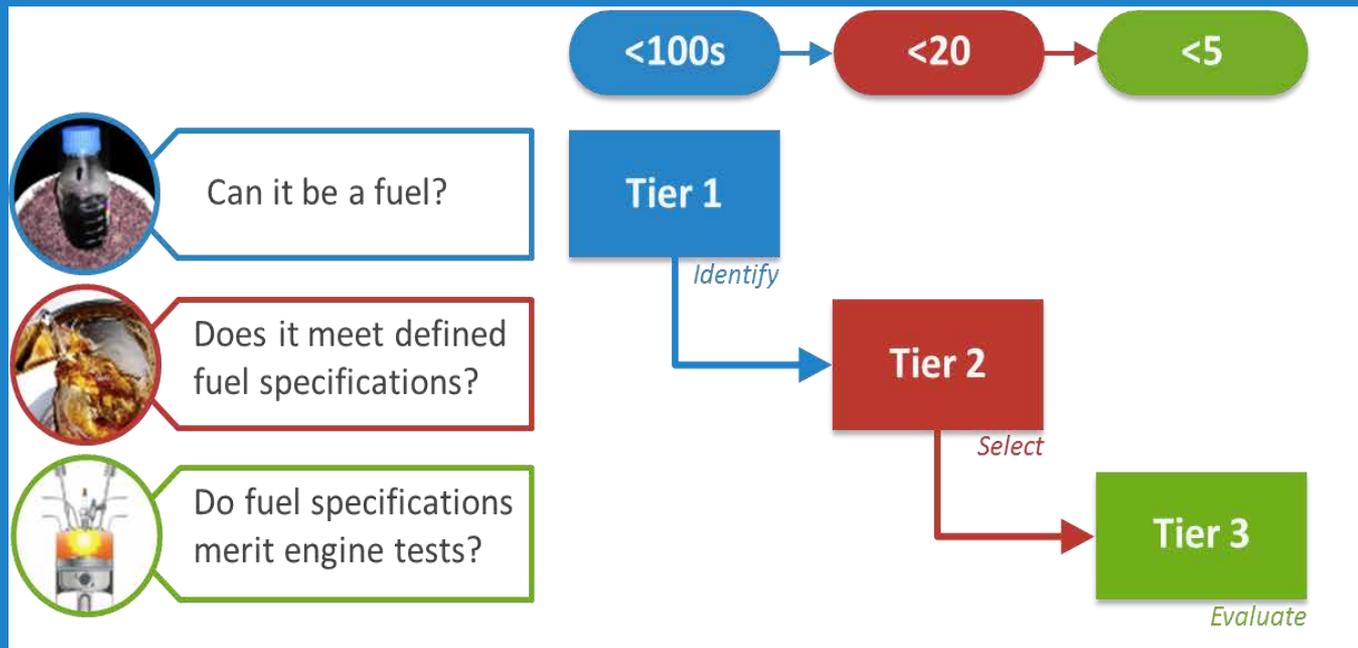


- Generate potential bio-blendstocks from *existing* conversion pathways
  - Biochemical
  - Thermochemical
  - Chemical/hybrid
- Measure fuel properties
- Develop fundamental understanding of how bio-blendstock chemistry determines fuel properties
- Develop understanding of fuel properties on engine performance



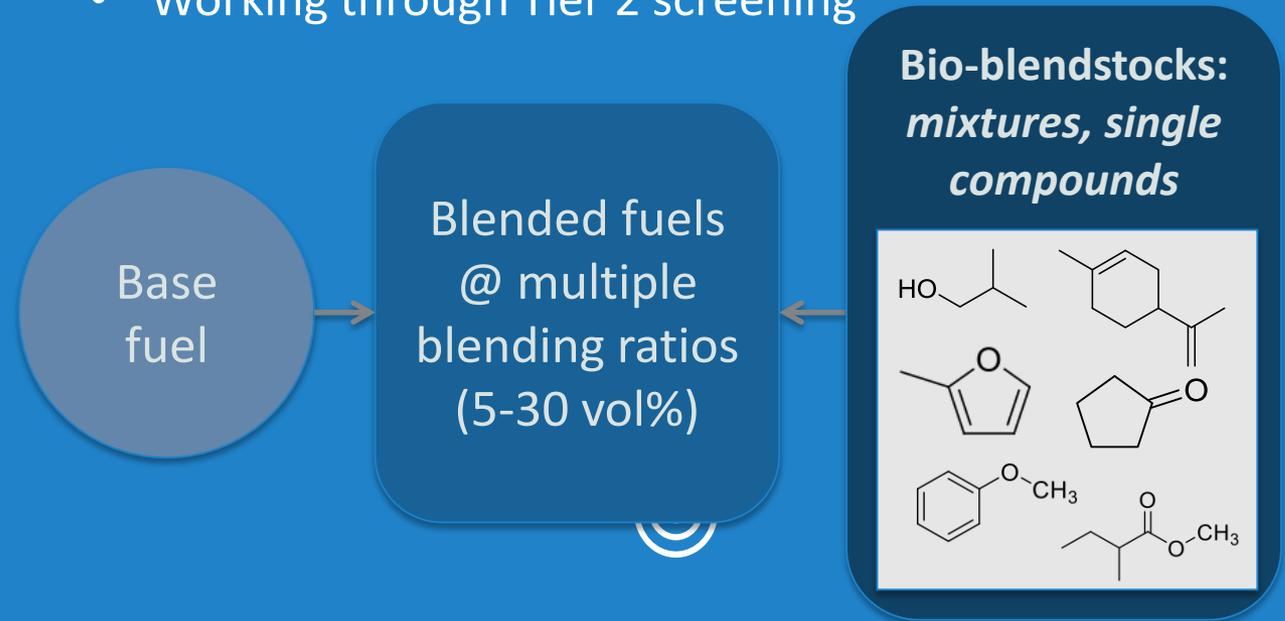
# Tiered process enables effective evaluation of fuel properties

- Define fuel properties and target values for various combustion strategies
- Measure properties of neat bio-blendstocks using tiered approach
- Investigate bio-blendstock behavior in blends with base fuel



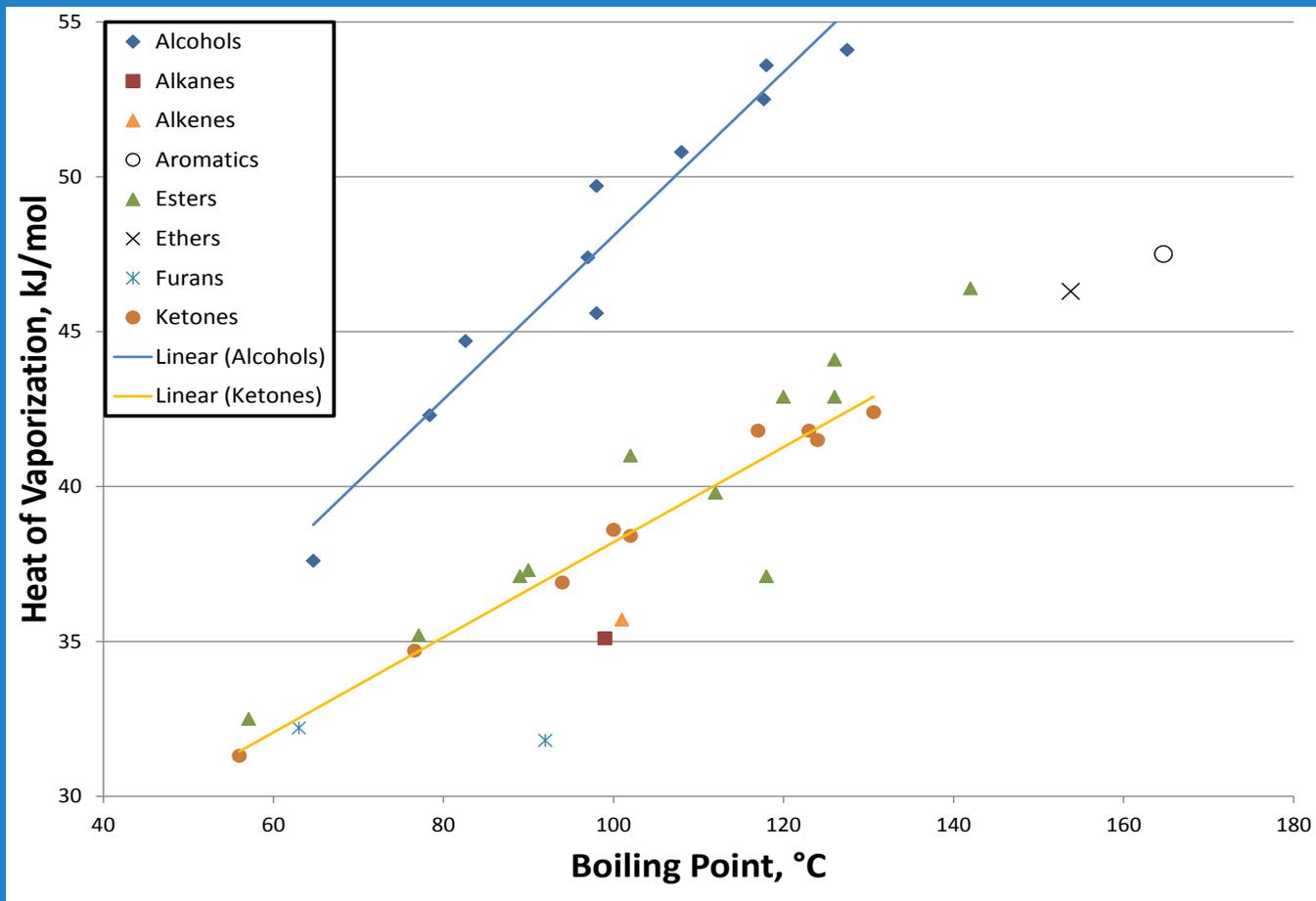
# Spark ignition candidates identified

- Identified 9 molecular classes most suited for further evaluation as blendstocks
- Applied tiered screening process to more than 400 potential candidates
- Focused on high octane components (>98 RON)
- 40+ candidates passed Tier 1 screening
  - Includes alcohols, esters, ethers, ketones, alkanes, alkenes, aromatics, furans
  - Working through Tier 2 screening



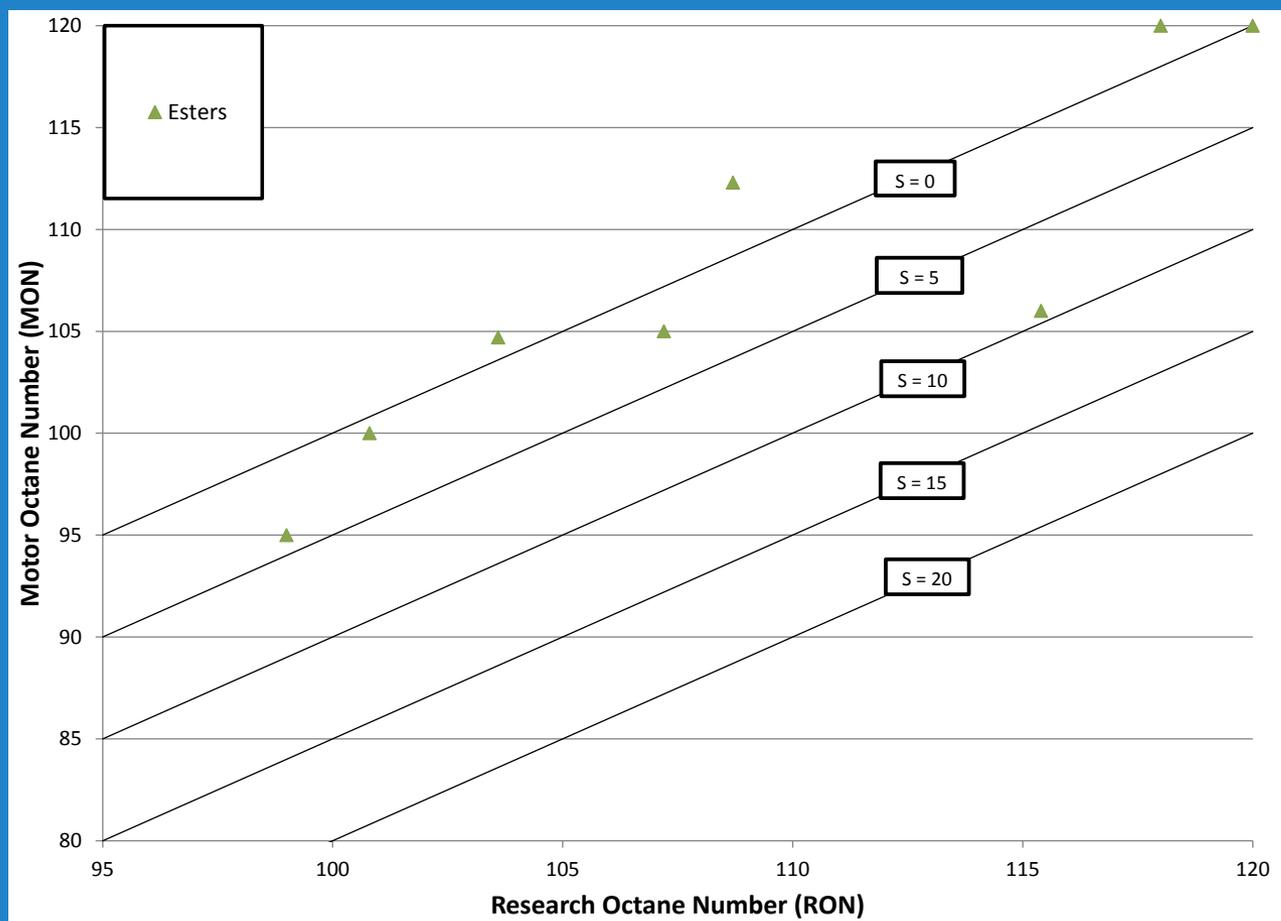
# Analysis of fuel properties show interesting trends

- As an example, alcohol heats of vaporization are higher and increase more rapidly than other functional groups
- Heat of vaporization increases engine efficiency through “charge cooling”



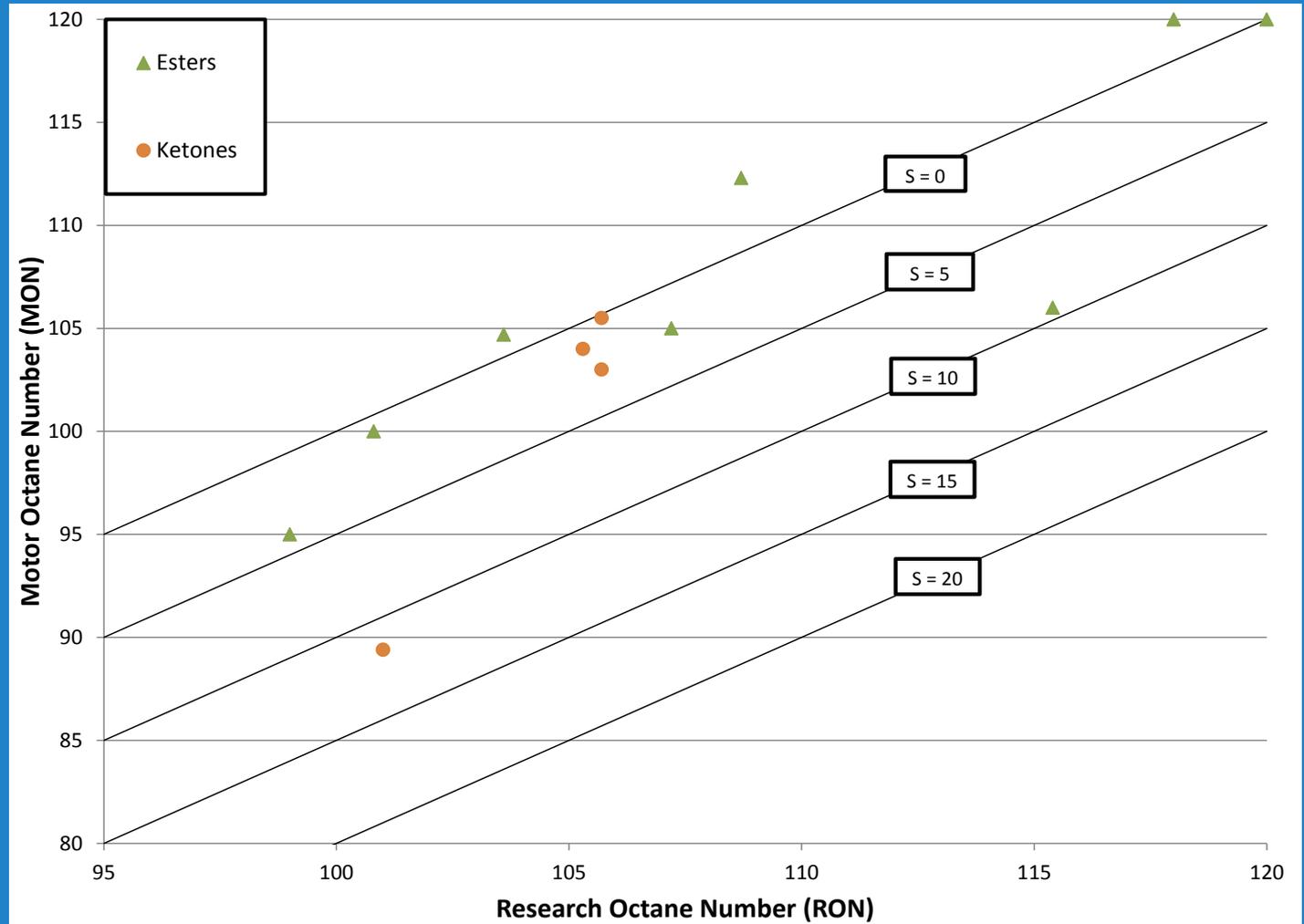
# Bio-blendstocks may offer efficiency benefits

- As another example, higher S (RON-MON) improves efficiency of downsized, boosted engines
- Bio-blendstocks offer another “knob” to turn



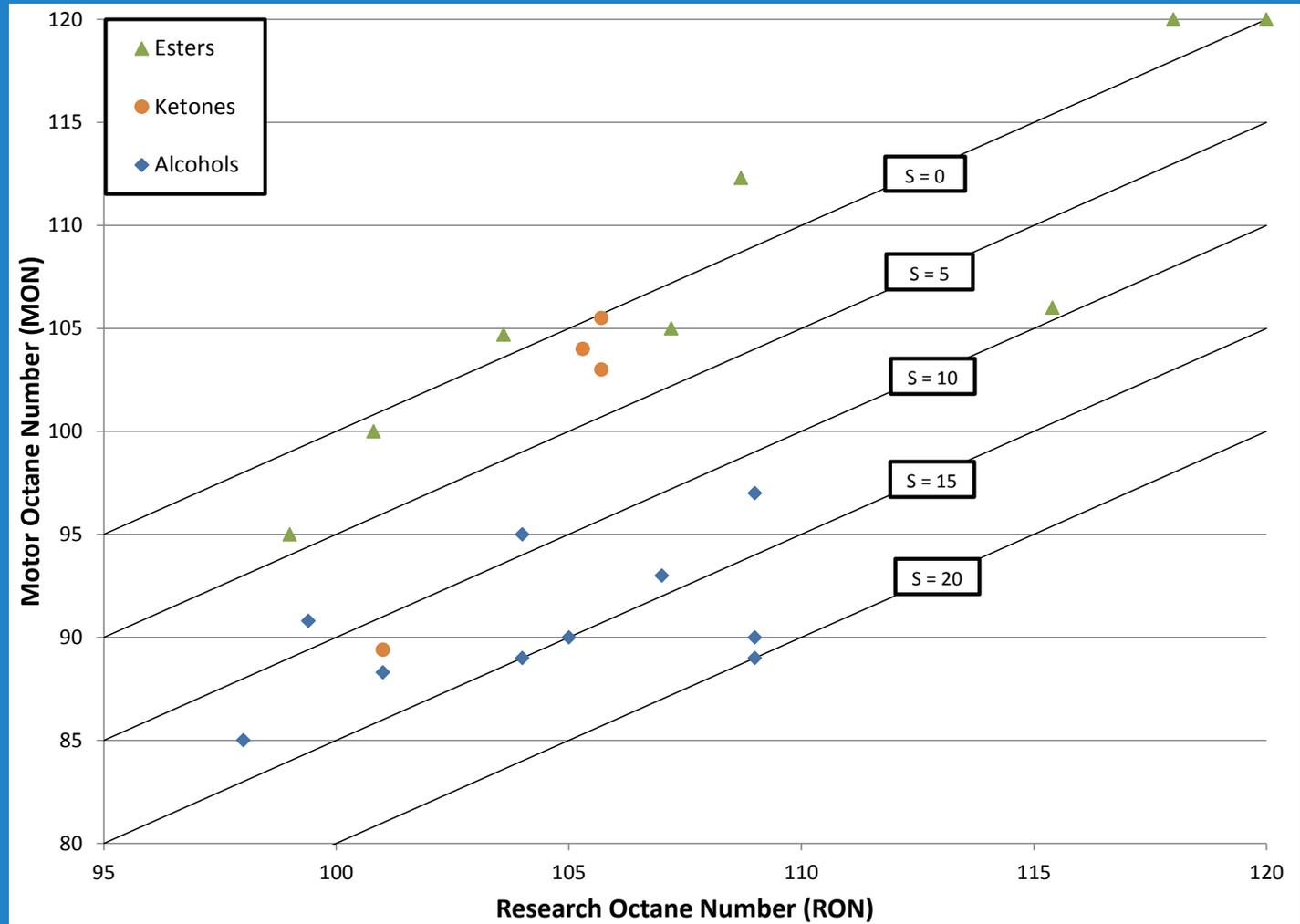
# Impact: Bio-blendstocks may offer efficiency benefits

- Higher S (RON-MON) improves efficiency of downsized, boosted engines
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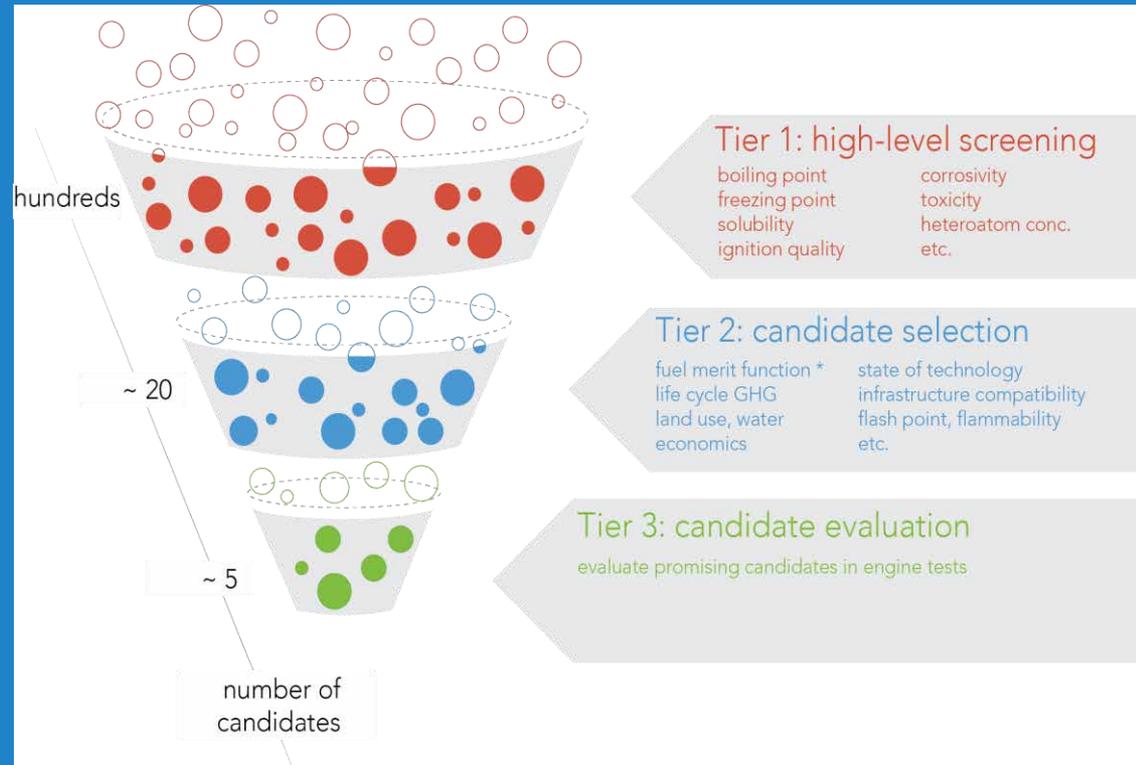
# Impact: Bio-blendstocks may offer efficiency benefits

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# What is next: Engine testing and extending analysis to advanced compression ignition

- Finish Tier 2 screening, including measuring blend properties
- Engine test matrix developed by AED and FP teams
- Identify combustion strategies
- Determine most important properties
- Identify, screen and test candidates



## What is next: Engine testing and extending analysis to advanced compression ignition

- Developed extensive Fuel Property Database
- Developing useful chemistry-fuel property and engine behavior correlations
- Working with kinetics experts to understand origins of combustion property variations
- Identified multiple promising candidates for further development

