



Successful Conversion of Carpet Into Clean Energy

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Background

- In mid-2014, we became aware of an emerging problem in the carpet industry
 - Spreading impact of California AB 2398
 - Limits on landfilling post-consumer carpet (PCC)
 - Polyester carpet is difficult to economically recycle, nylon not so limited
 - ~2 million tons of post-consumer carpet is landfilled annually in the U.S.
 - ~40% is polyester
 - Landfills are reaching their capacity
 - New landfills are costly and time consuming
- We had technical discussions with nearby Interface, Inc.
 - Presented the capability of the Thermolyzer technology
 - Interface offered to **fully fund** a test of carpet shreds
 - They supplied nylon shreds, CRI supplied polyester shreds (no backing)
 - The tests of both materials were conducted in Germany in Sept. 2014



4 Ton Per Day Demonstration Plant



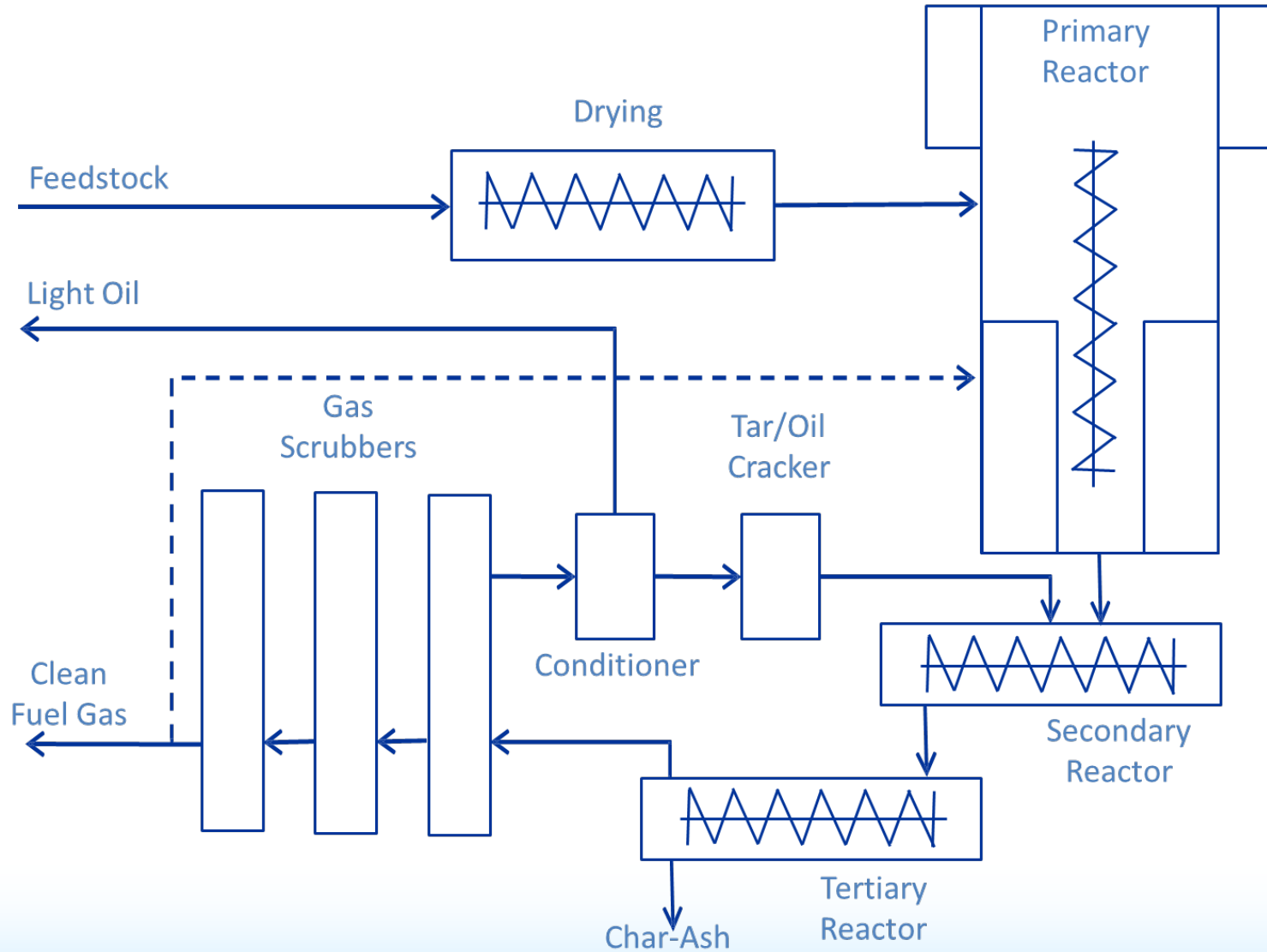


Why Is Thermolyzer Different?

- Thermolyzer system has undergone development over the last 17+ years
 - Two pilot plants, one 44 TPD commercial plant
- Thermolyzer system overcomes deficiencies of other gasification approaches
 - Continuous, oxygen-free process
 - Tars and oils recycled to make more clean Fuel gas (VOCs < 1ppm)
 - No dioxins or furans formed
 - Has processed many types of waste
 - Tires, plastics, carpet, auto shredder residue (ASR), MSW, wood...
 - Meets the most rigid environmental standards
- Economically viable technology, but:
 - Dependent on location, plant size, feedstock and offtake choices
 - Costs have been worked out, but details are critical



Thermolyzer Process



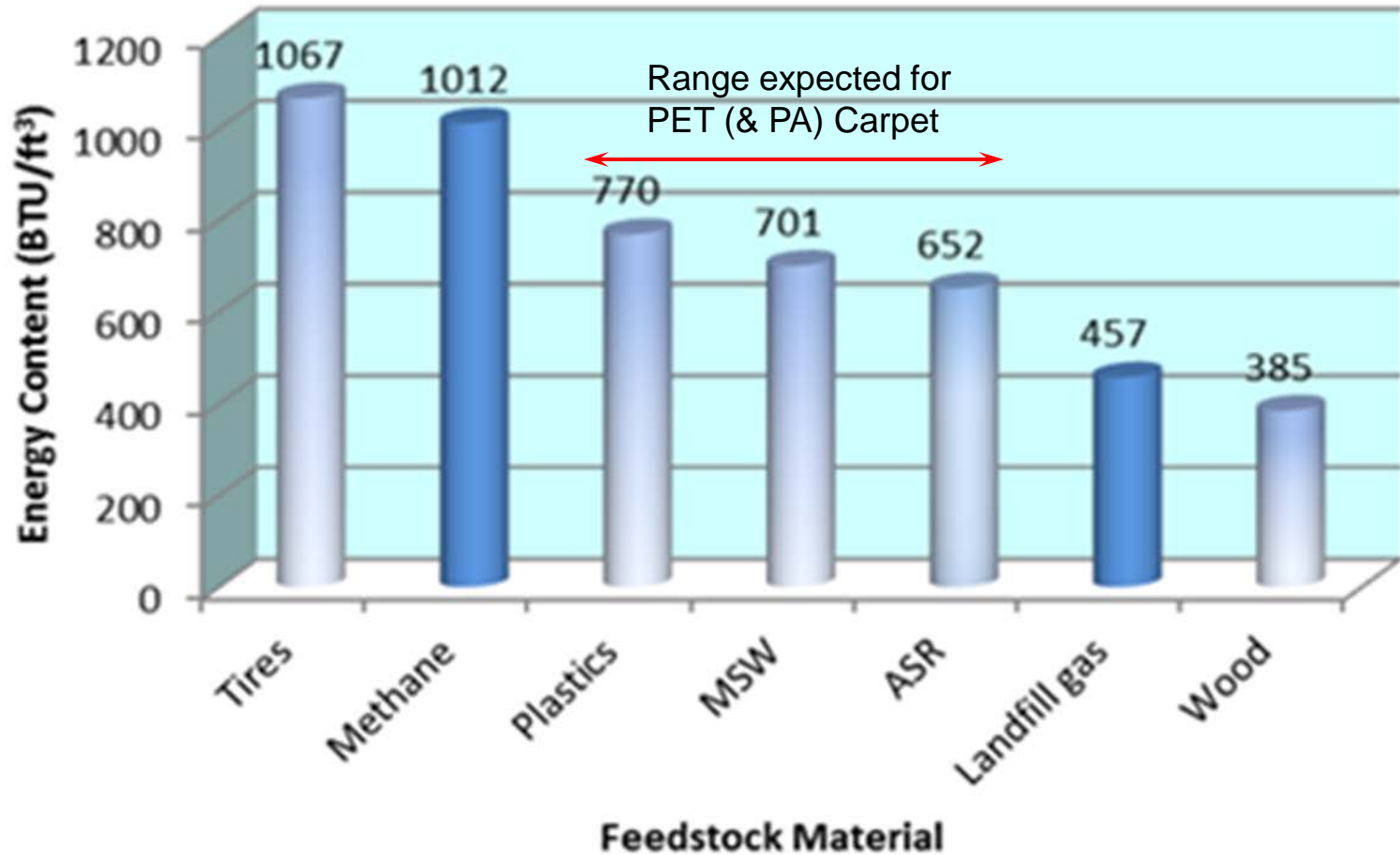


Results of Carpet Test September, 2014

- Test of PET and PA carpet shreds at the 4 ton/day research facility
 - Eric Nelson, Interface and Carter Hallock, Rethink Green, witnessed the test
 - Bob Peoples and Joe Yarborough have also reviewed the data
- Tests covered two days (one day for each type)
 - Both PET and PA samples processed easily and quickly
 - The resulting Fuel gas was clean with no VOCs or other contamination
 - Mass balances were determined plus analyses of all gases
 - Chlorine content in one sample was 1.6% - process is tolerant to 7% Cl
- Thermal content of the carpet was similar for both:
 - PET: 7158 Btu/lb.; PA: 6762 Btu/lb.; (PP estimated at ~14,000 Btu/ft³)
 - Heating value of the generated Fuel gas: PET 438 Btu/ft³, PA 567 Btu/ft³
 - Fuel gas output met EPA (& German) emissions requirements
- These results established the feasibility of using Thermolyzer technology to process PCC and provide clean Fuel gas and/or other outputs
 - Would need similar tests to confirm thermal value of different feedstock



Examples of Other Thermolyzer Test Results



Note: Solid blue bars are literature values



Key Factors in Determining Thermolyzer Economics

- Type of carpet input
 - Selvage (~16,800 Btu/lb.)
 - Mixed carpet (PET, PA, backing - ~7,000 Btu/lb.)
 - Shredded to $\leq 2''$ - # of shredders? (e.g. 2 for mixed carpet)
 - Windsifter, magnetic separators likely needed for bulk carpet
 - Tipping fees impact economics
- Estimated Fuel gas output from 44 TPD plant
 - Selvage: 39,000,000 Btu/hr.; Mixed PET/PA: 16,000,000 Btu/hr.
 - Fuel gas can be used for: burners, or steam and electricity production/distribution
 - Each has different economics; point of use dependent
- If making electricity
 - PPA required from power company
 - Price significantly impacts economics ($> 6\text{¢}/\text{kWhr.}$)
 - With selvage: 36,000 MWhrs./yr.; mixed carpet: 14,000 MWhrs./yr.
- Char sales
 - Quality of char and point of sale impact economics (est. \$20/ton)
- Avoided landfill costs also enter in to economics (est. \$30/ton)
- Plant cost tbd (~\$10 million or so depending on above factors)
 - Labor (24 hr./day operation), permitting, waste water, safety standards, etc.





What Does This Mean for You?

- The Thermolyzer Technology has processed PET (and PA) carpet successfully
 - Produced a clean, environmentally acceptable Fuel gas
 - That can be sold, used to make/sell steam, or make/sell electricity
 - Produces a char which can also be sold
 - Or potentially be recycled into carpet process
 - We're seeking to build a plant at any location in the U.S.
 - Carpet, tires, ASR as feedstocks (even in a single facility)
- The economics are dependent upon numerous factors
 - Size of plant: 44 TPD to 88 TPD and multiples; feedstock type(s)
 - Customer for Fuel gas or steam: e.g. a refinery (paid on energy content)
 - Electricity value depends on location and securing a PPA with the utility
 - Tipping fees, char sales...
- Without a detailed analysis of a given location, costs are ROMs
 - The devil is in the details but:
 - \$10 million for a 44 TPD facility is in the ballpark
 - With an approximate payback time of 4-5 years, depending on the exact details
- We'd look forward to detailed discussions if you're interested