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HERE WITH YOU. HERE FOR YOU.

EPA Renewable Natural Gas Technology Transfer Workshop

September 26th 2017

Donald Chahbazpour

National Grid's Journey

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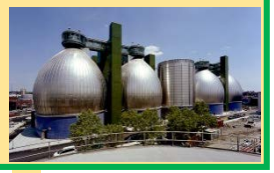
2010

NEWTOWN CREEK DEMONSTRATION PROJECT

Partnership with NYC-DEP to convert New York City's waste water into a source of clean energy



RFS – RECOGNITION OF ENVIRONMENTAL ATTRIBUTES

Educating stakeholders on EPA's Renewable Fuel Standards (RFS) program and helping customers by facilitating transactions to monetize the environmental attributes

CURRENT STAKEHOLDER ENGAGEMENT

Facilitating Customer Projects

- Working with customers, project developers, technology providers and consultants

Education & Advocacy

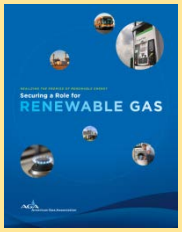
- Associations, policy makers and regulators

RNG RESEARCH & WHITEPAPER

Outlined the value of RNG as an alternative energy source. Analyzed the potential for RNG by feedstock and technology in NY, MA, RI & NH. Paper also provides a vision for a sustainable gas network and a roadmap on how to get there

NATIONWIDE RNG REPORT

Partnership with AGA & AGF to determine the national potential for RNG



NEW YORK STANDARD INTERCONNECTION GUIDELINE

Collaborative effort to develop a revolutionary interconnection guideline. The purpose of this effort is to specify gas quality standards and streamline the process of connecting RNG projects to the gas distribution network

2017

Newtown Creek Demonstration Project

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- Public-private partnership with NYC Department of Environmental Protection
- Largest wastewater treatment plant in NYC
- The project will inject enough RNG into the distribution network to heat ~2,500 homes
- Reduce CO2 emission by about 16,000 tons annually
  - Equals ~3,000 car reduction for one year
- NYC is introducing an additional feedstock, food waste, which will boost biogas production

Newtown Creek wastewater treatment plant in Brooklyn, NY

Source: New York City Department of Environmental Protection

Recovery System Layout

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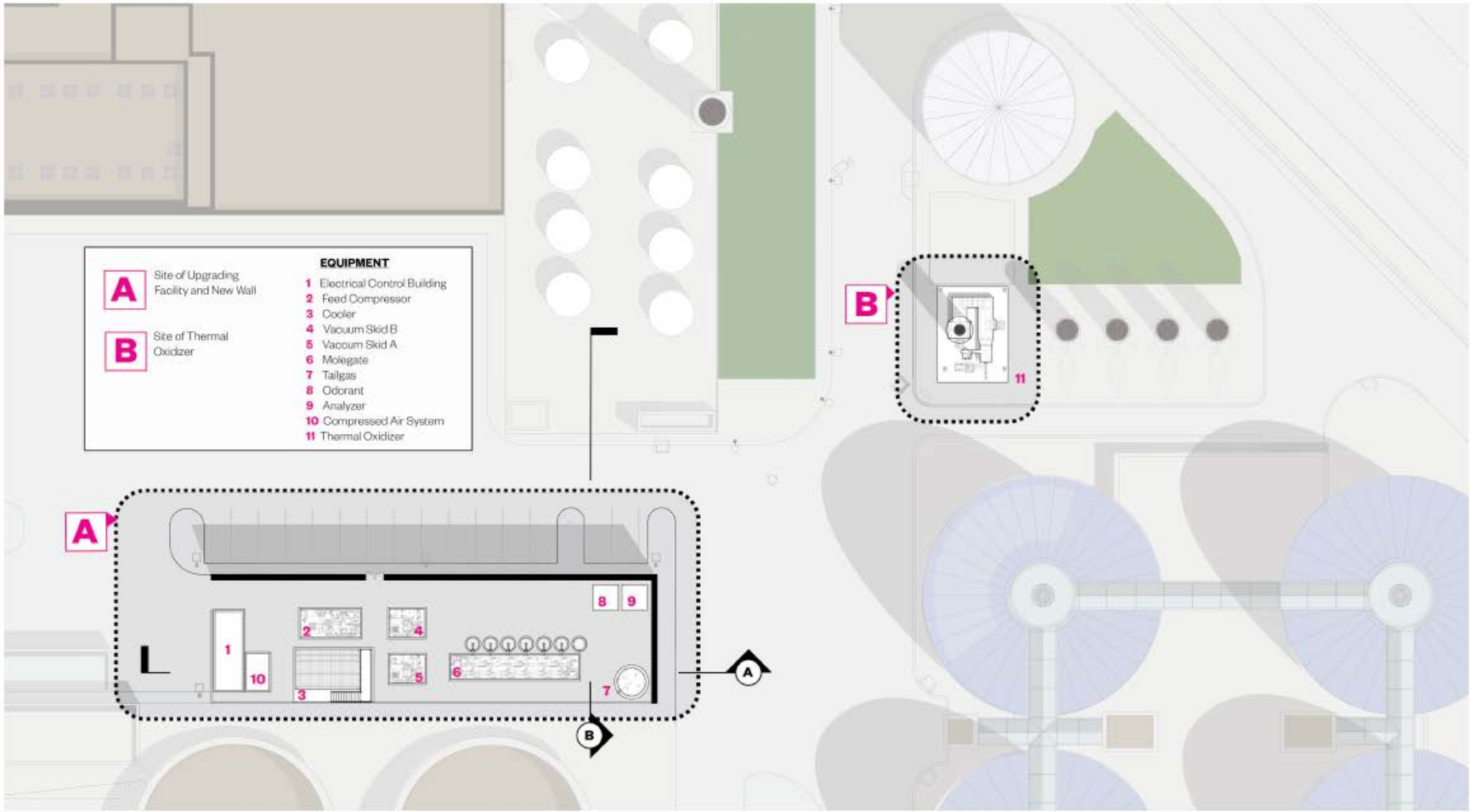


Department of Environmental Protection
ennead

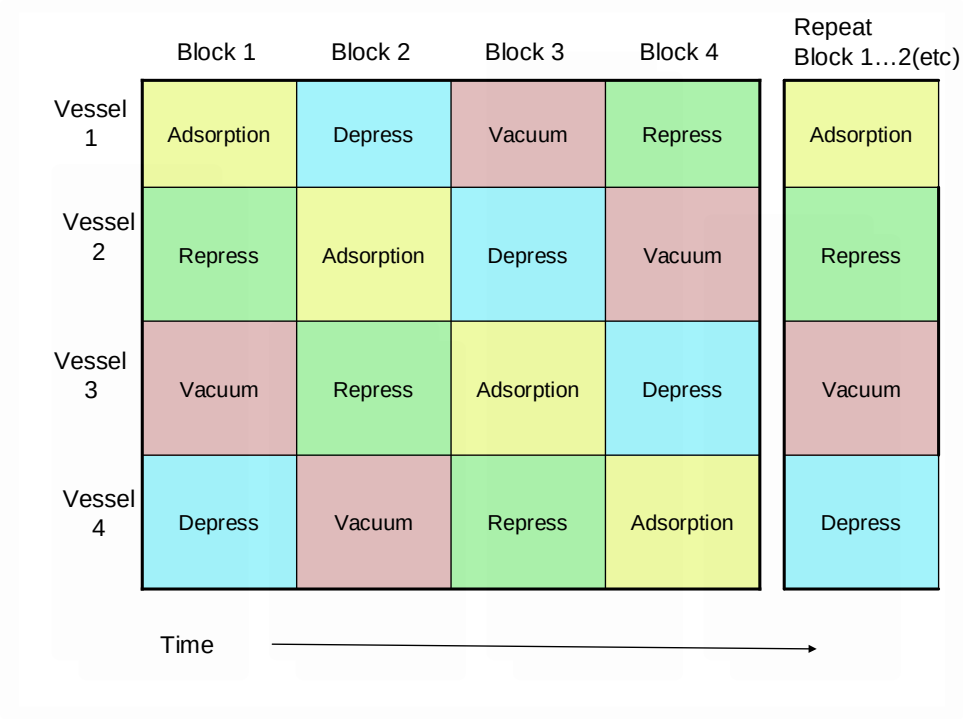
National Grid Digester Gas Conditioning System at Newtown Creek
March 17, 2017

Plan
Scale: 1/32"= 1'-0"

Proposed Site

Technology – Pressure Swing Adsorption

- 4 Repeated Cycles – Identical Vessels



- ADSORPTION – At 100 psig, material adsorbs H_2O, H_2S, siloxanes and CO_2 and allows the product methane to flow through the bed and out as pipeline quality gas.
- DEPRESS - Depressurizes from 100 psig to near atmospheric pressure. This takes place in a stepwise manner with, for example, methane rich gas taken from the vessel transferred to two of the rack mounted buffer tanks for temporarily storage
- Once near atmospheric pressure, the vessel on VACUUM is exposed to the vacuum pump to remove H_2O, H_2S, siloxanes and CO_2 by pulling vacuum and applying a small methane rich sweep purge (with gas from step #2). The desorbed gas is sent to the tail gas tank at 3 psig before passing to the thermal oxidizer.
- Once regenerated the vessel needs to be brought back to feed pressure which is conducted during the REPRESS step. Here gas put into the buffer tanks is removed and used to pressurize the vessel. Once re-pressurized, the vessel is placed back on the ADSORPTION step.