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Potential to Develop Biomethane, Biogas, and Renewable Gas to Produce Electricity and Transportation Fuels in California

2017 Joint Agency IEPR Workshop on Renewable Gas

June 27, 2017

Philip Sheehy, Technical Director
Jeff Rosenfeld, Sr Technical Specialist

Recap of questions posed:

1. How much growth of energy development and use from renewable gas, biogas and biomethane do you expect for each submarket (e.g., dairy and livestock, food waste and organic diversion, waste water treatment, landfill gas and agricultural/forestry and urban woody biomass residue)?

2. What key factors (i.e., incentives, technology advances, and business maturity) are required to be in place to achieve 2030 SLCP targets in California?

About ICF

- **Our team has worked with 25—30 clients across multiple RNG projects over last 24—36 months**

Market Advisory Services

Regulatory Impact Analyses

Reporting & Verification

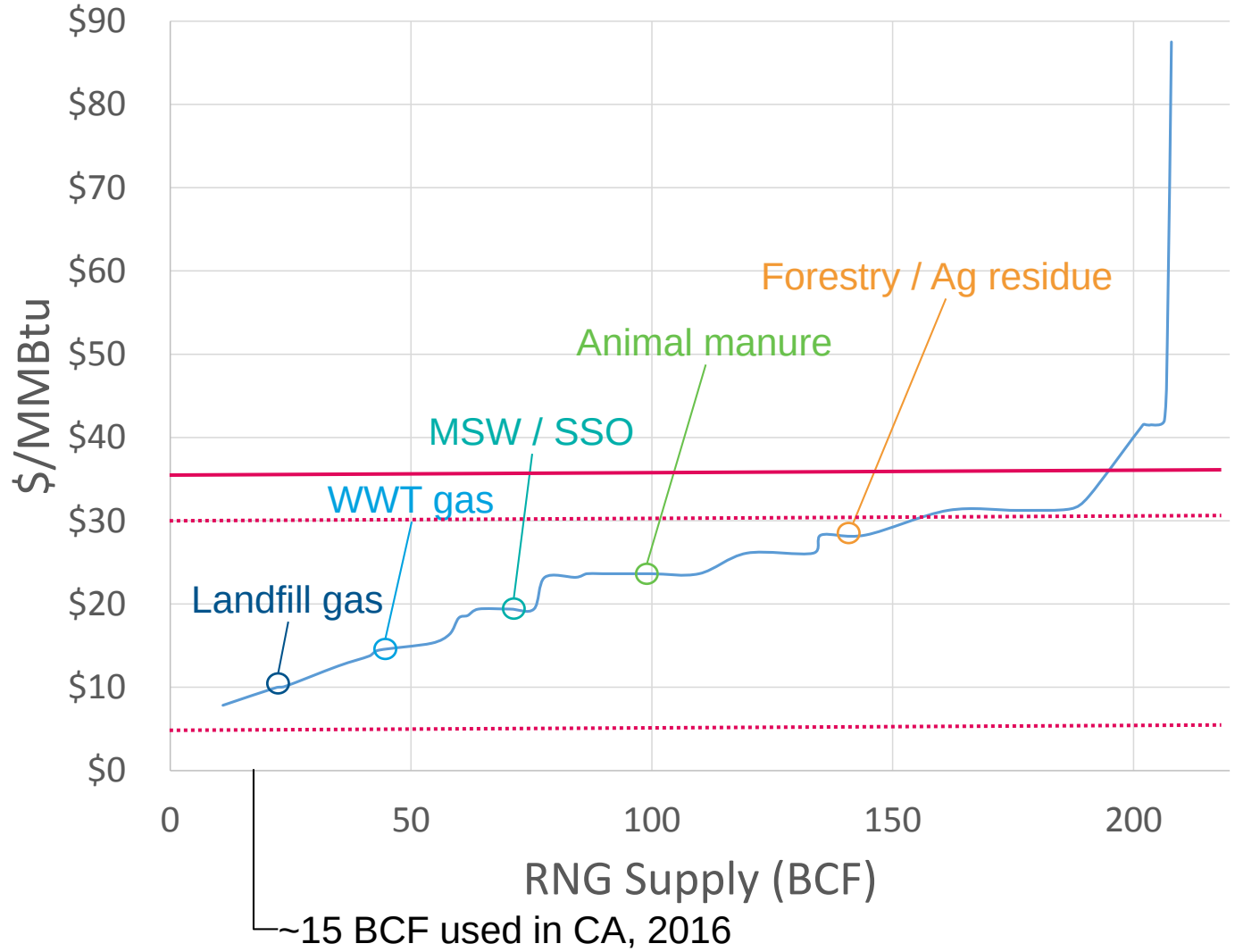
Lifecycle Analysis

RNG Production Potential

- **ICF estimates between 105—208 BCF per year of RNG production potential in California.**
  - Most near-term potential is via anaerobic digestion technologies: LFG, WWT gas, MSW/SSO, and animal manure

Feedstock	RNG Production Potential in CA (BCF/y)					
	UC Davis	AGF[a]		DOE BT[b, c]		ICF Estimates
		low	high	low	high	
Agricultural Residue	29.9	4.1	10.2	29.6	32.5	**29.6-32.5**
Animal Manure	18.7	8.4	28.0	2.2	9.9	**12.3-18.7**
Energy Crops[d]	70.9	0.0	0.0	0.0	0.0	**n/a**
Fats, Oils and Greases	6.2	n/a	n/a	n/a	n/a	**n/a**
Forestry and Forest Product Residue	78.0	4.7	11.8	8.9		**14.5-44.9**
Landfill Gas	50.2	27.4	54.8	n/a	n/a	**22-54.8**
MSW, food, leaves, grass	11.7	7.5	22.5	11.7	13.6	**22.5-50.1**
MSW, lignocellulosic	38.5			9.9	17.1	
WWT Gas	7.2	0.3	0.8	n/a	n/a	**4.1-7.2**
Total Potential	**311.3**	**52.4-128**		**62.3-73.1**		***104.9-208.3***

RNG Supply-Cost Curve (California only)



Landfill gas, 9, 20+ facilities

WWT gas, 4, 4-6 facilities

MSW/SSO, 7, 7-10 facilities

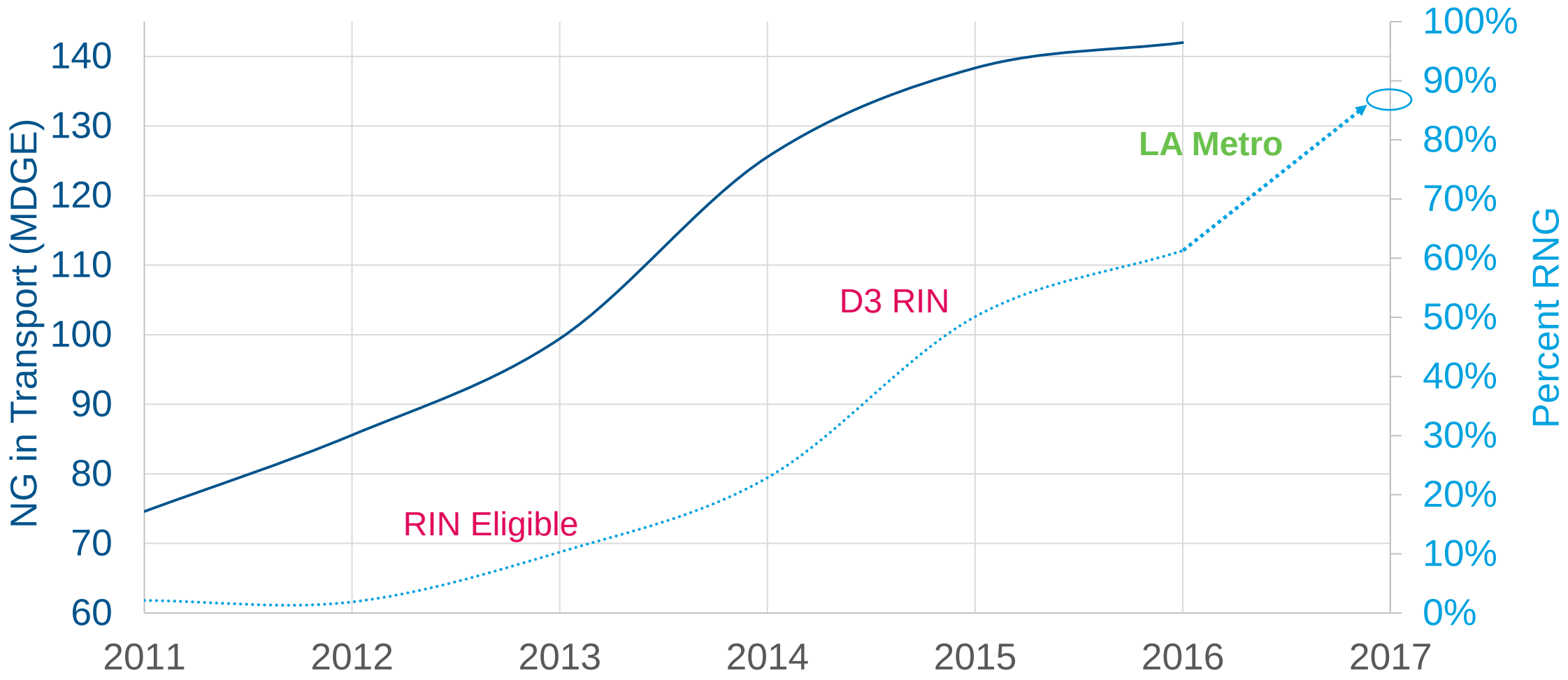
Animal Manure, 8, 8 facilities

Forest/Ag Residue, 0, 0 facilities

LCFS+RIN
RINs, $2.50/D3

LCFS, $80/t, 35 g/MJ

RNG in the Transportation Sector



CARB, LCFS Quarterly Reported Data, April 2017

Key Factors

- **The market for RNG will not expand substantively absent a more significant policy intervention that values the environmental benefits; the fuel is too expensive.**
- **Focus on a Renewable Gas Standard**
  - Move towards price and supply certainty, while avoiding any disruption of other markets where RNG has been successful
  - Need to diversify fuel offering—all going to transportation at this point.
  - Introduce gas utilities as counterparty (socialize costs, engage core aggregators and non-core suppliers, etc).
- **In the absence of a RGS, introduce a price floor in the LCFS Program**
  - The “financial mechanism” that is in play is an intriguing opportunity and challenge. Why not simplify it and introduce a floor price in the LCFS Program?
- **Incentives**
  - Supply of RNG is not the barrier: Need more demand. Target NG growth in transportation sector (hint: trucks)
    - Understand political/environmental context: RNG vs Electrification
  - Interconnect (obligatory mention, secret is out folks, interconnect in California is expensive). Unclear if this is THE barrier.
  - Other incentives: Highly unlikely to move the market given the amount of capital required to get these projects funded

Thank you

Philip Sheehy, Philip.Sheehy@icf.com

Jeff Rosenfeld, Jeffrey.Rosenfeld@icf.com