SCS Non-Regulatory Landfill Gas Modeling for Recovery & Utilization

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SCS ENGINEERS

Different Uses for LFG Models

1. New Source Performance Standards (NSPS) compliance
2. Annual or semi-annual emissions inventories (EIs)
3. Greenhouse gas (GHG) emissions reporting
4. Estimate size requirements for designing gas collection and control systems (GCCS)
5. Facility planning/design of LFG-to-electricity (LFGE) projects
6. Planning/design, and due diligence assessment of renewable natural gas (RNG) projects

Distinction is blurred outside of SCS due to dominance of regulatory applications

U.S. LFG to RNG Projects (2024 – LMOP database)

- About 70% of RNG is from landfills (~20% Ag waste)
- 123 landfills with operational RNG projects processing ~540 million ft^3 LFG/day (375,000 scfm)
- Another 102 planned or under construction (320 million ft^3/day)

Pine Bend, MN

Landfill Methane Generation and Emissions

- Landfill methane is unlike other GHG emissions sources
  - Waste has a “legacy” and keeps emitting
  - Rate that waste decays and produces methane is unknown (outside SCS)
- Methane emissions (flux) eludes measurement for now
  - Emissions monitoring = reporting 500 ppm exceedances and sampling of surface methane concentrations
  - Drone and satellite measurements of emissions provide intermittent coverage
- Measured LFG flow rates & methane percentages are the only available data

Sauk Trail Hills, MI

Regulatory LFG Models

- Estimate LFG generation which is unknown
  - Emissions = Modeled Generation – (Recovery x % destruction) – Oxidation
- EPA's Landfill Gas Emissions Model (LandGEM) – 1995, 2005, 2025
- Regulations driving emissions estimation
  - NSPS (NMOCs trigger GCCS requirements)
  - Emissions Inventories (Title V requirements)
  - GHG emissions (Methane Reporting Rule)

Sources of LFG Model Uncertainty

1. Dependence on simplistic EPA regulatory LFG models and “industry standard” input assumptions
2. Difficulty accounting for the effects of moisture and waste composition on waste decay and methane generation
3. Forecasting future waste disposal, particularly when changing from historical conditions due to increased organics diversion
4. Uncertain collection efficiency since LFG generation is unknown

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Moisture Effects on Waste Decay Rates

- Waste decay rates are highly dependent on waste moisture levels, yet exact relationship is poorly known & studied
- High moisture levels can lower recovery <u>despite</u> higher generation

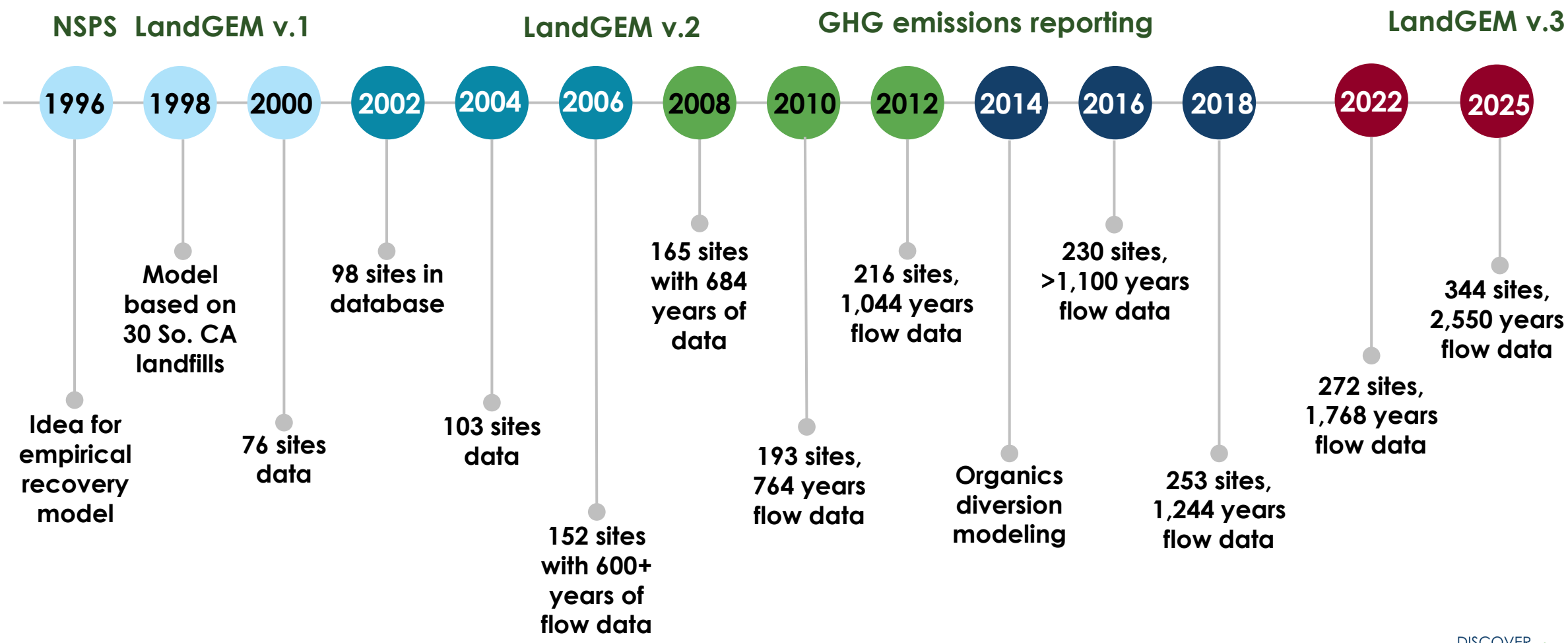
Arid western United States vs. Wet rainforest in Columbia

Non-Regulatory SCS LFG Recovery Model

- Estimates LFG recovery, not generation
  - Model explains observed recovery – empirical basis
- Nearly 30-year history
  - Flow-calibrated LFG model first developed in 1996
  - Supported by hundreds of hours of research

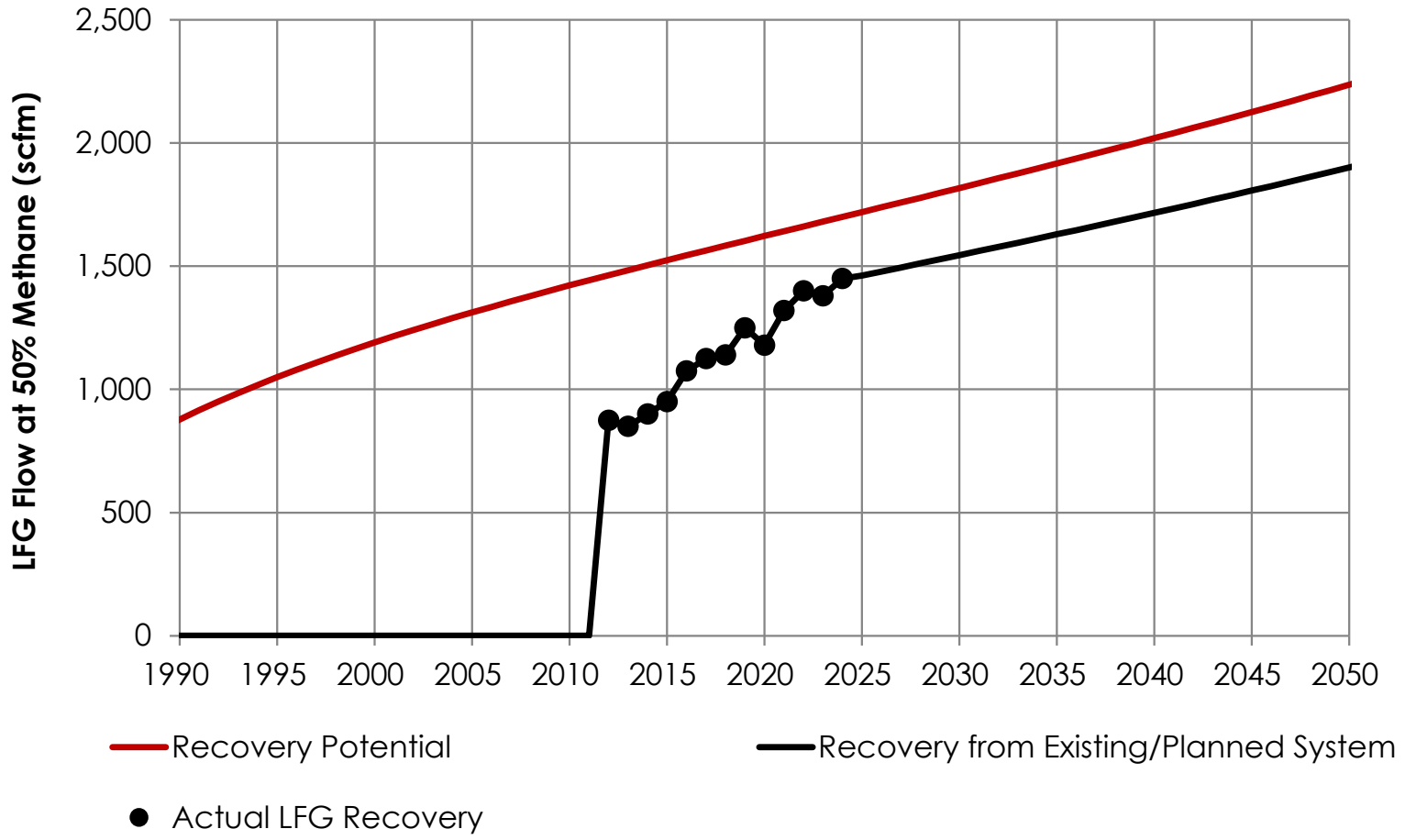
Dry Creek OR

SCS LFG Modeling History - Growth of Calibration Database



What Does SCS LFG Recovery Model Estimate?

- Maximum LFG recovery potential
- LFG recovery given the limits of the collection system



DISCOVER 2025
SCS ENGINEERS
All about the WHY

Evaluating Collection System Efficiency / "Coverage"

- Well spacing and coverage of waste footprint
- Well depth/perforations
- Liquids management
- Cover type and thickness
- Collection system maintenance, repair, and regular expansions
- Well monitoring, adjustment, automated wellheads

LRI, Washington

Why SCS LFG Recovery Model is Unique

- SCS database of calibrated LFG models for 345 landfills with >2,580 years of flow data
- Leverage SCS industry-leading expertise in evaluating collection system performance
- Allows for empirical model calibration to measured LFG recovery

Renewable natural gas project developers depend on SCS LFG recovery projections for estimating revenues

Thank you!
Questions?