Scaling up Cellulosic Biofuels
Ideas & Experience

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Scaling up Bio

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A Long Time Player in Cellulosic Biofuels

- **Leading developer of cellulosic ethanol**
  - $500+ million invested & 300+ patents issued or pending
  - Making cellulosic ethanol since 2004 in demo plant
  - Pioneer in the field with our first commercial plant underway
- **Top five firms serving the U.S. fuel market with cellulosic biofuels**
  - Supply 10% of U.S. cellulosic biofuel with landfill gas to CNG
  - Developed renewable hydrogen as a drop-in biofuel
- **History with blue chip partners**

raízen · Goldman Sachs · PETRO-CANADA

Enzyme Business: Historical relationships include:

Roche · DSM · novozymes Rethink Tomorrow

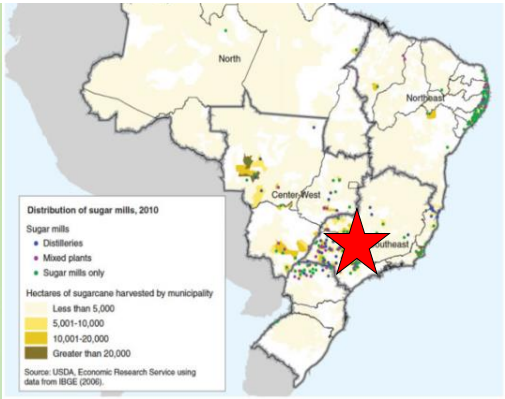
Our First Commercial Cellulosic Ethanol Plant: Costa Pinto

Bolt-on facility to a Brazilian Sugar Cane Ethanol Plant

- **Partnered with Raizen**

- **Brazil's largest cane processor**
  - 24 sugar & ethanol mills,
  - ~ 65 m tonnes/yr. crushing
  - ~ $30 billion sales
  - ~ 40,000 employees

Sao Paulo State, Brazil



Raízen Costa Pinto Mill, Piracicaba, Brazil

The Costa Pinto Cellulosic Ethanol Facility

- US ~$100 million
- Bagasse as feedstock
- 40 m litres/yr. 2G ethanol

Supply 10% of U.S. cellulosic biofuel with landfill gas to CNG

- **Biogas is:**
  - Produced by anaerobic digestion of waste
  - Sourced from landfills and waste digesters
  - It can be collected and purified into renewable natural gas for transportation

The Challenge: Scaling up New Process Technology

- Over $2 billion has been invested in commercial cellulosic biofuel production
- Ten technology platforms have been scaled up (including several failures)
- Five platforms, including logen's, are enzyme based cellulosic ethanol
- It has been a struggle to achieve highly reliable commercial operation

The Challenge: Scaling up New Process Technology

- **Start with an example: logen's R6 technology generation**

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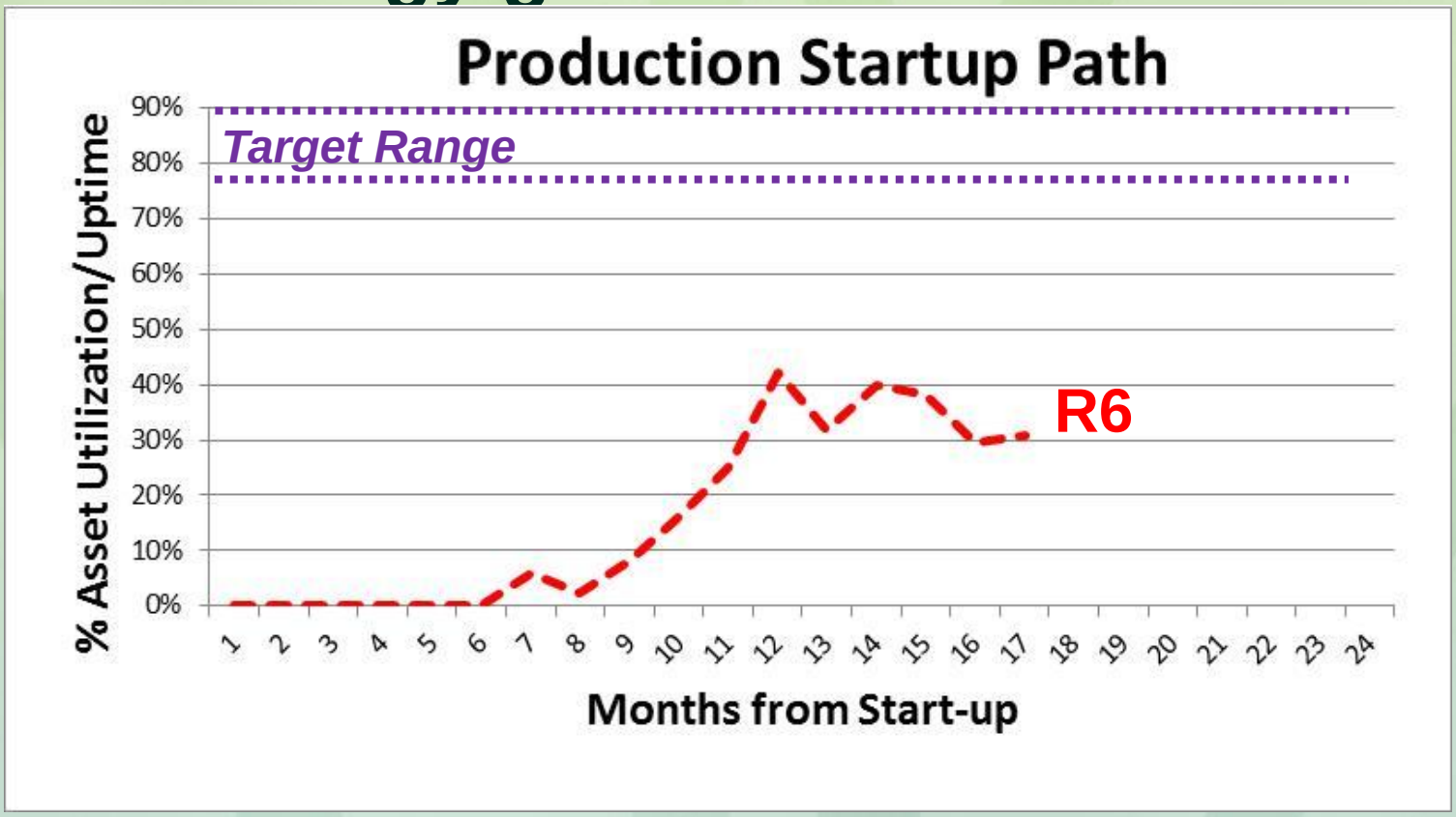

What could possibly go wrong?

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Problem:

- Straw bridging

What could possibly go wrong?

- **Problem:**
  - **Lines plugging**

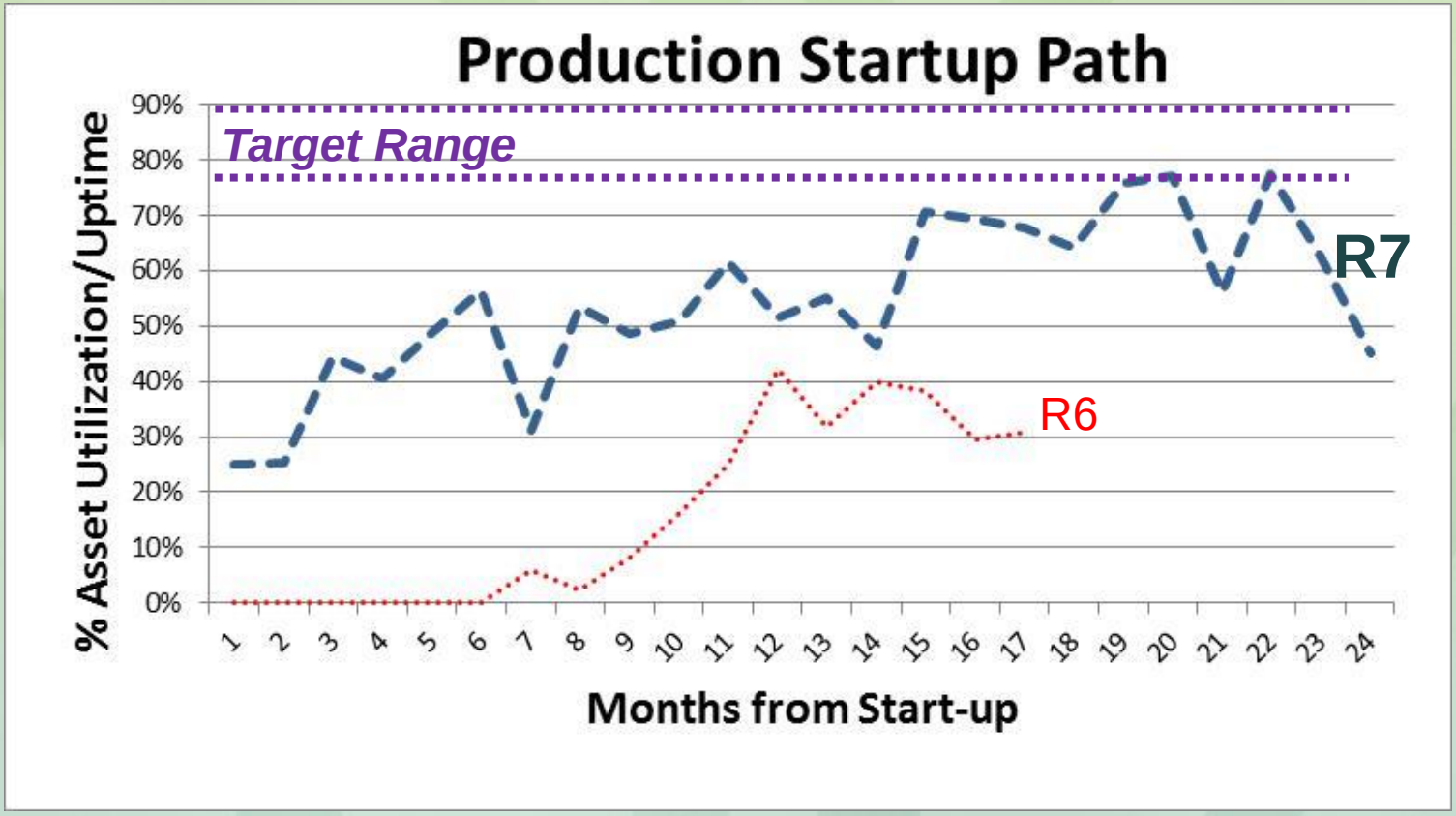
What could possibly go wrong?

Problem:

- Severe deposits leading to system shut-downs

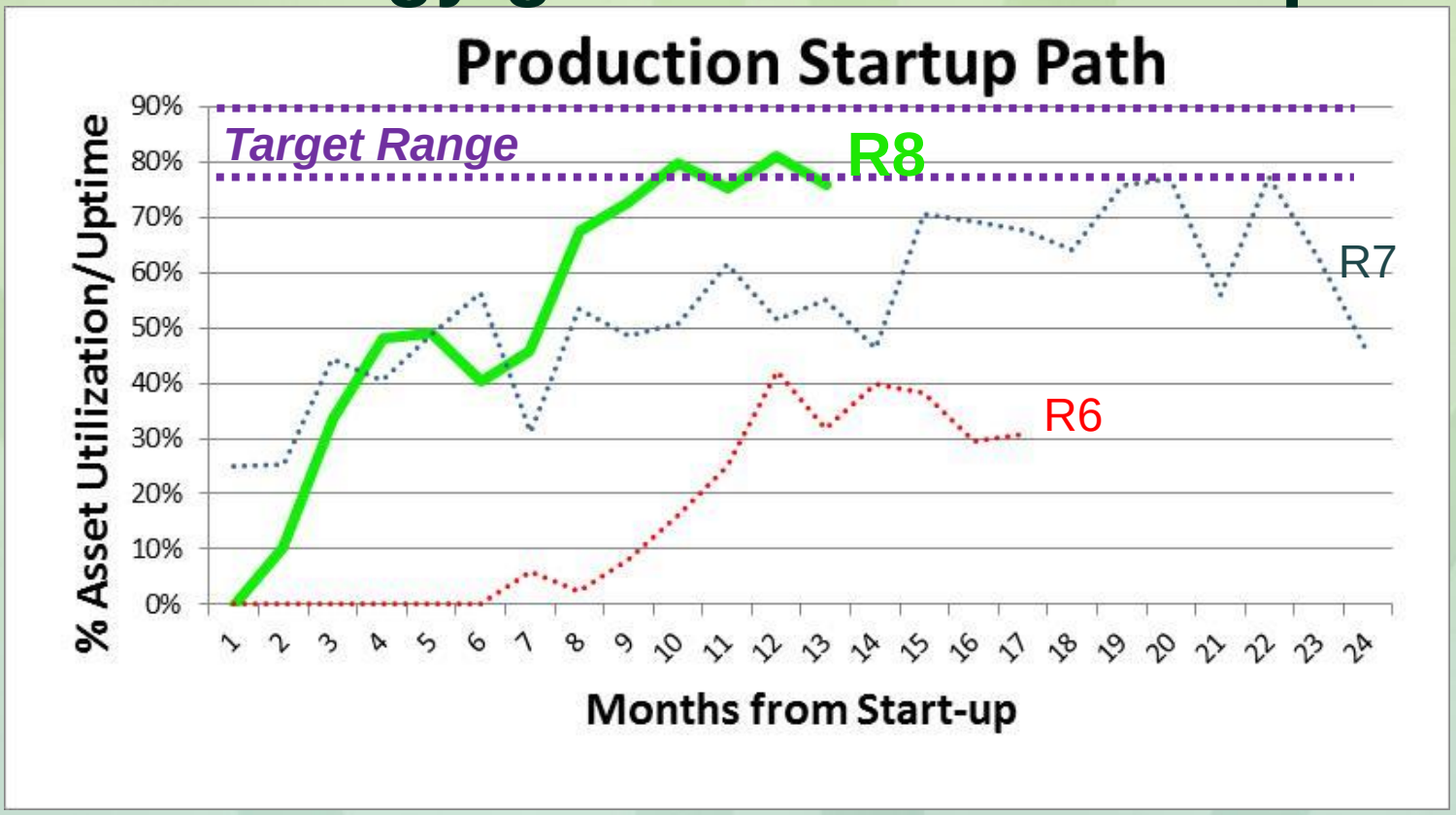
The Challenge: Scaling up New Process Technology

- **Significant improvement with R7**



The Challenge: Scaling up New Process Technology

- **Further improvement with R8 – the technology generation scaled up in Brazil**



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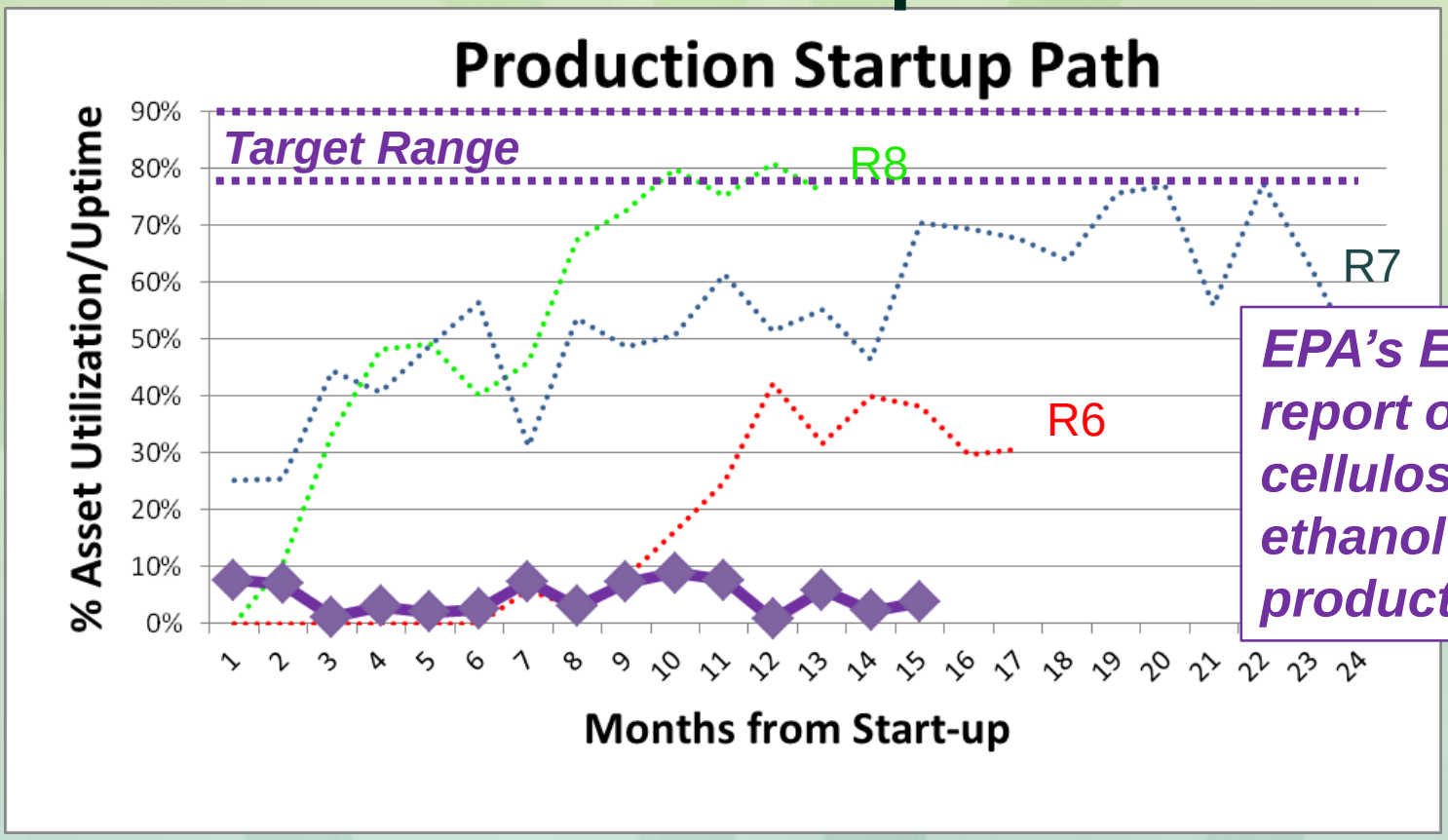

EPA's EMTS report of U.S. cellulosic ethanol production

Scaling up Cellulosic Biofuels – *Ideas & Experience*

1. **It is really tough to deliver new technology**
   - Over $2 billion invested in commercial cellulosic biofuel production
   - Ten technology platforms scaled up (including several failures)
   - It has been a struggle to achieve reliable commercial operation
2. **Investors need, need, need confidence in the market to see things through**
3. ***But …* Confidence in "environmental markets" is fragile**

IOGEN CORPORATION

Thank You