n-solv Corporation

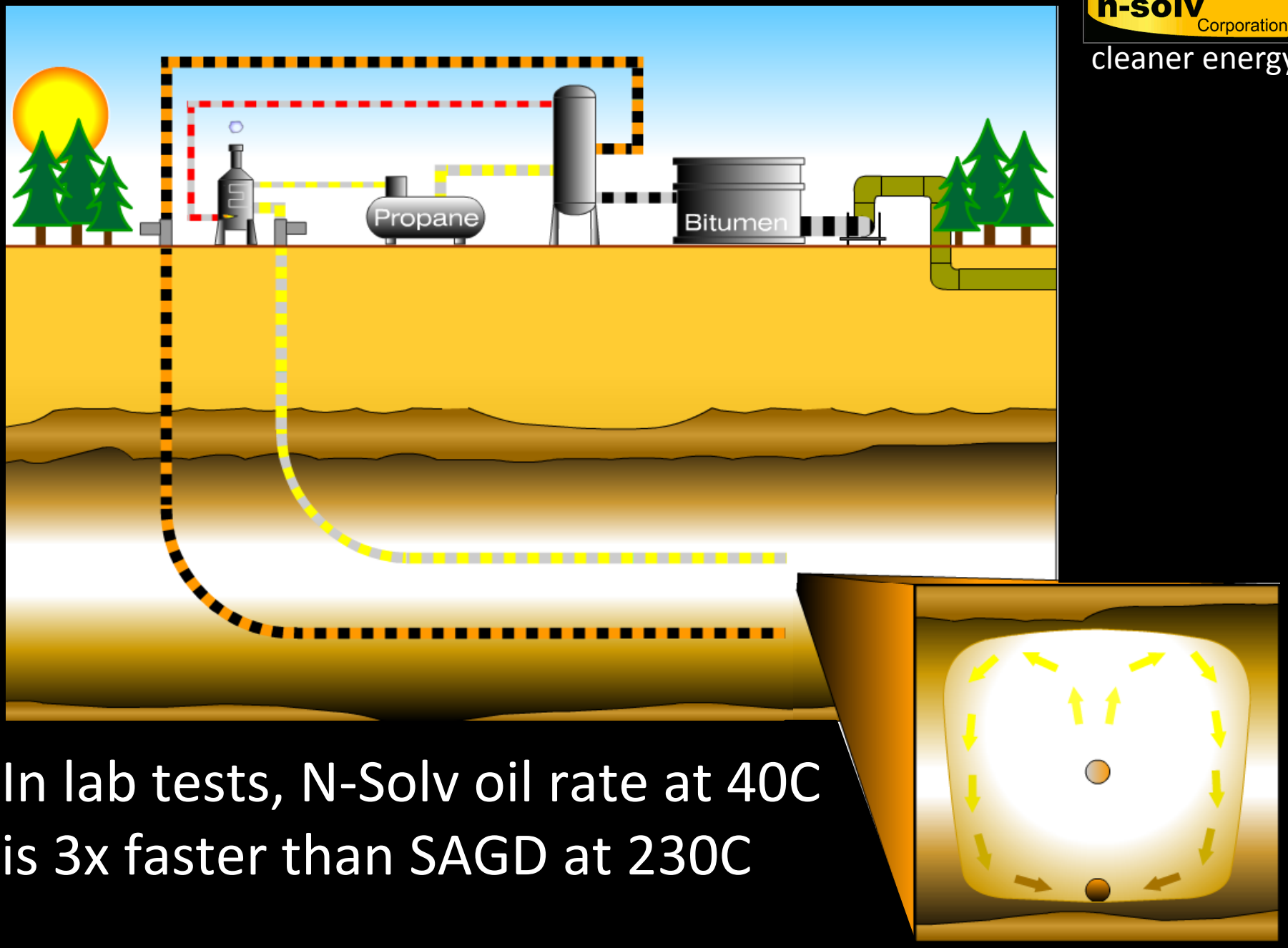
Testimony of Dr. John Nenniger

Congress of the United States
House of Representatives
Committee on Energy and Commerce
Calgary, AB

March 20, 2012

n-solv Corporation

cleaner energy



- In lab tests, N-Solv oil rate at 40C is 3x faster than SAGD at 230C

n-solv Corporation

n-solv Corporation
cleaner energy

Key Features

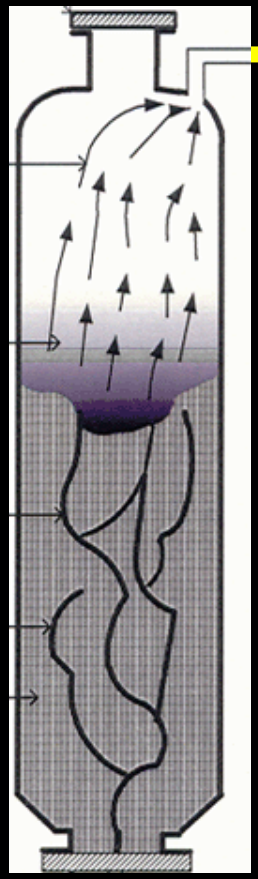
- 85% reduction in temperature (energy)
- No water
- Reduces Well to Tank GHG's by 93 kg/bbl
- Increases oil value 23%
- Reduces Capex and Opex by 30+%
- 2x netback of steam (profit/bbl oil)
- 3x capital efficiency of steam (profit/Capex)
- Access to 1300 billion bbls of stranded bitumen
- Understated economics

n-solv Corporation
cleaner energy

N-Solv Economics

SAGD Coker Shrinkage

n-solv Corporation
cleaner energy

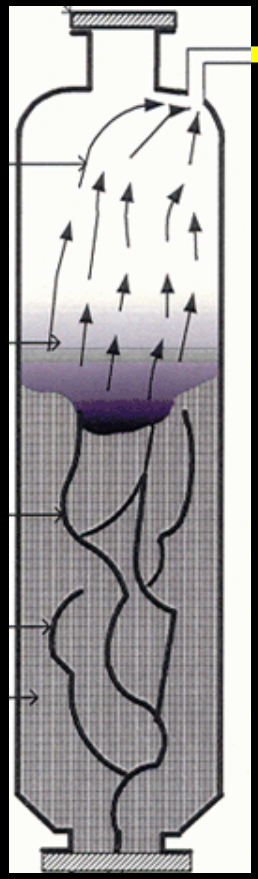


100 kg Synthetic Crude

23 kg coke
waste sent to landfill

SAGD Coker Shrinkage

n-solv Corporation
cleaner energy



100 kg Synthetic Crude

- N-Solv eliminates the shrinkage

➔ A higher yield of refined products

➔N-Solv oil is 23% more valuable

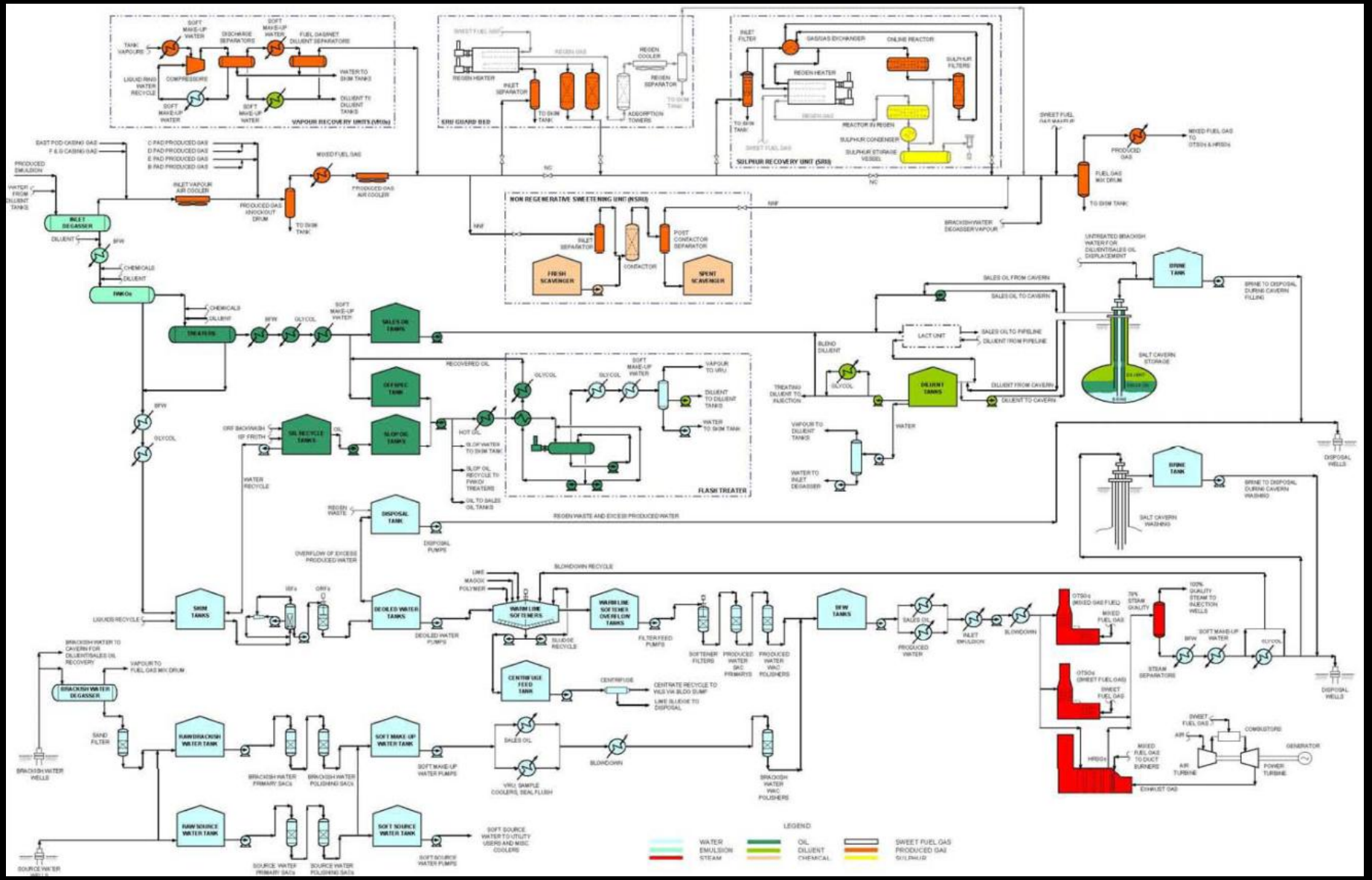
23 kg coke

~~*waste cement*~~

to landfill

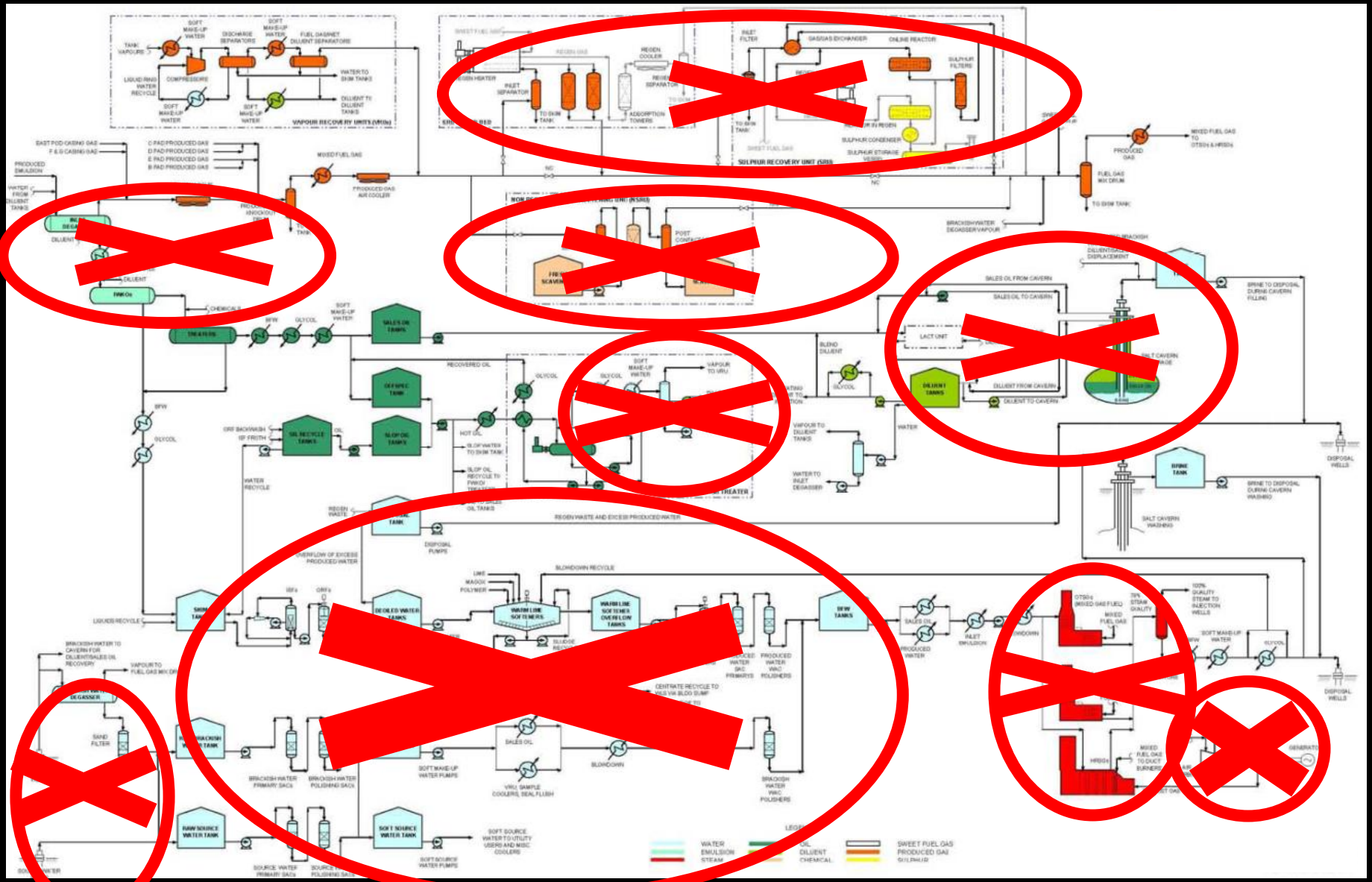
SAGD Process Flowsheet

n-solv Corporation
cleaner energy

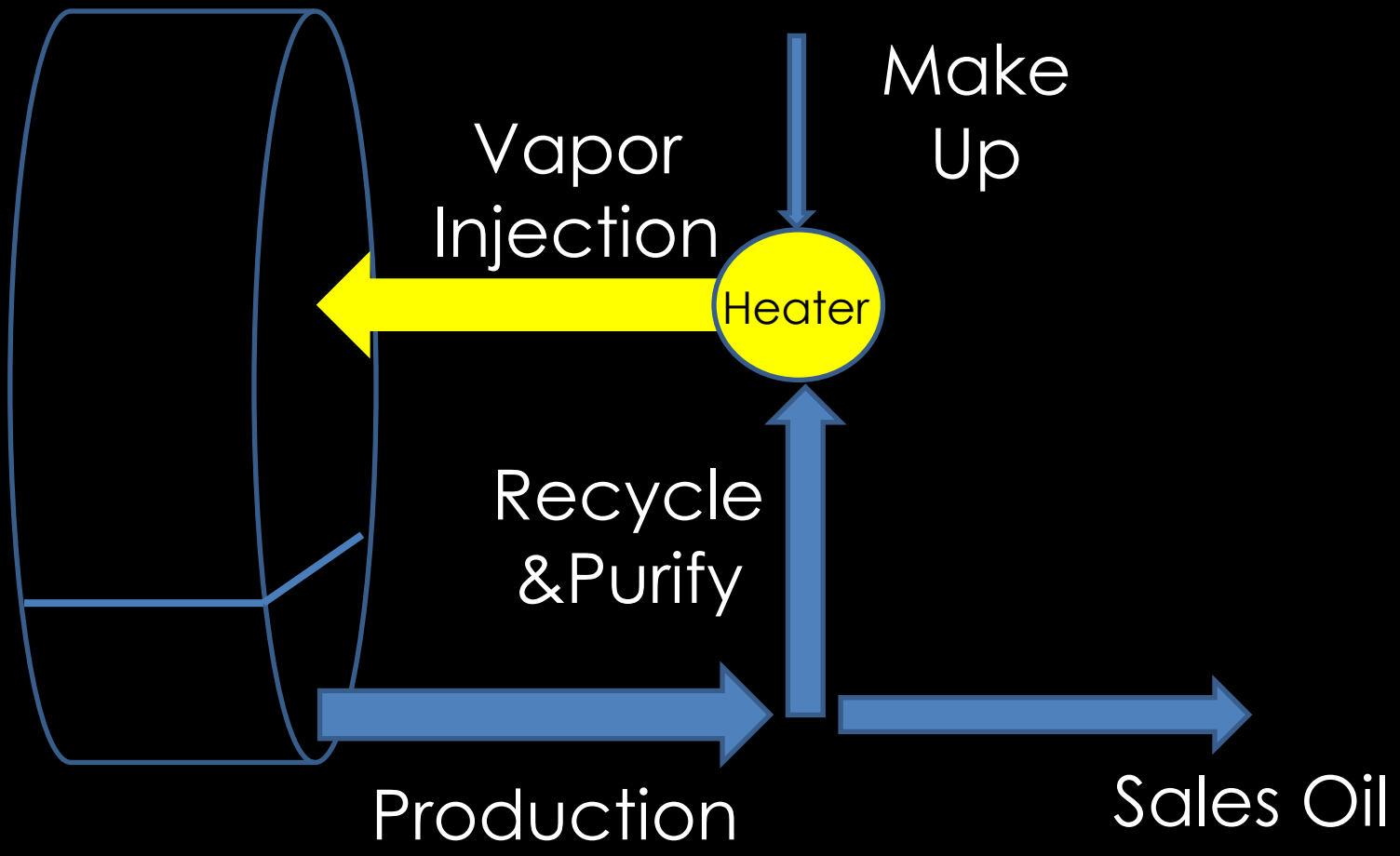


Eliminate Steam to Cut CAPEX & OPEX

n-solv Corporation
cleaner energy



Solvent Loop

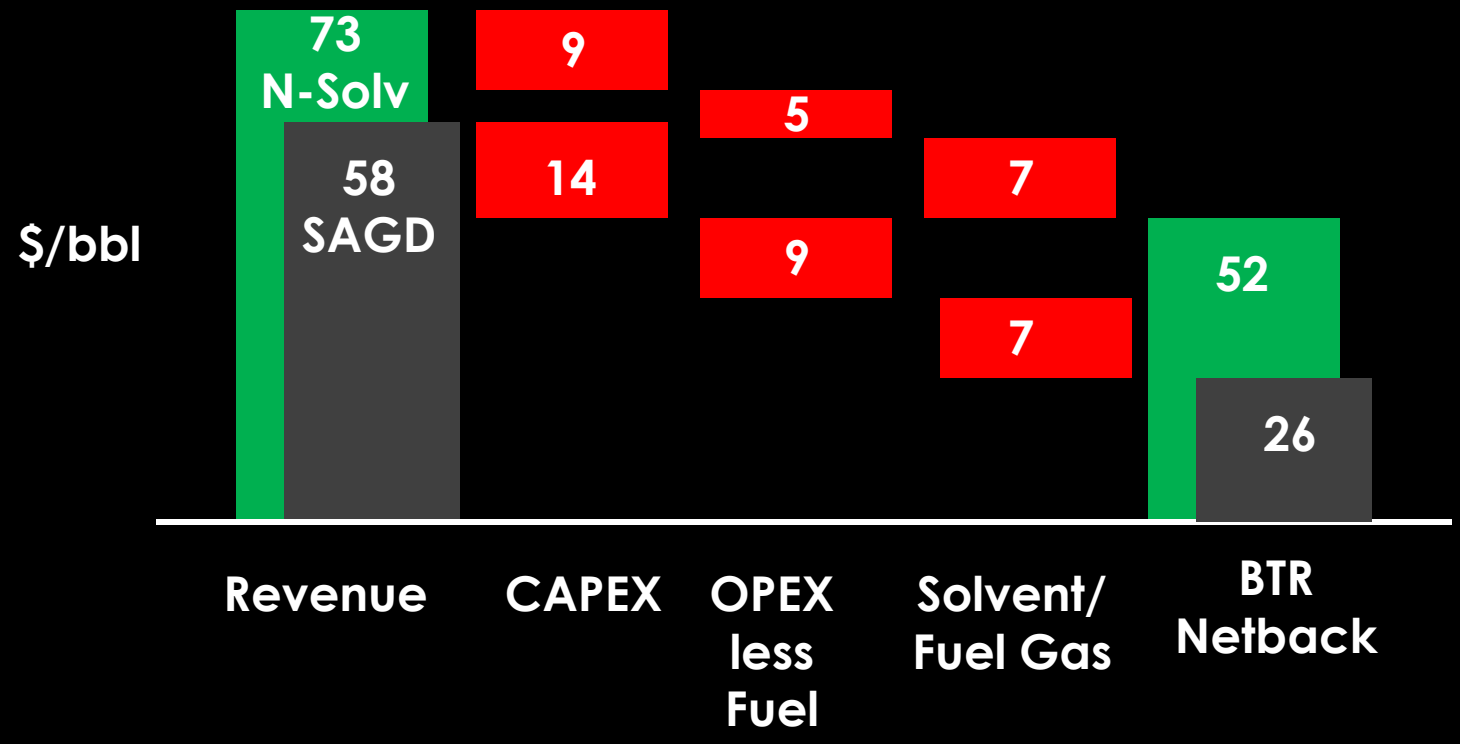


- Steam holdup in SAGD is 10% (0.1 bbl / bbl oil)
- If solvent holdup is 20% → solvent cost ~$7/bbl oil

N-Solv Economics

n-solv Corporation
cleaner energy

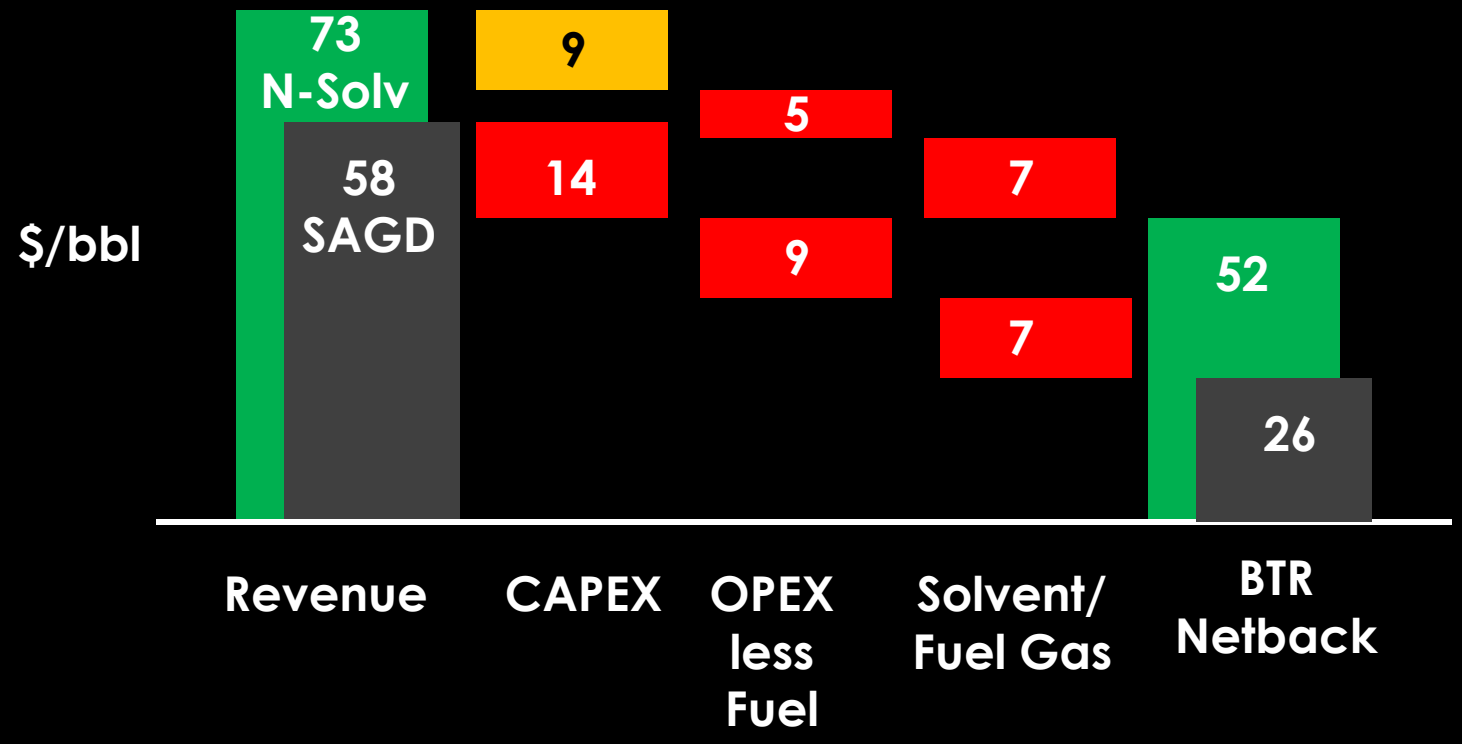
Strong economics drive adoption



N-Solv Economics

n-solv Corporation
cleaner energy

Strong economics drive adoption



Business Case is Understated

n-solv Corporation
cleaner energy

- Assumes oil rates are 35% of the lab measured rates
- Assumes solvent holdup is 2x that of water in SAGD
- Assumes no debt leverage
- Assumes “stick built”, but a modular plant design would provide substantive cost savings

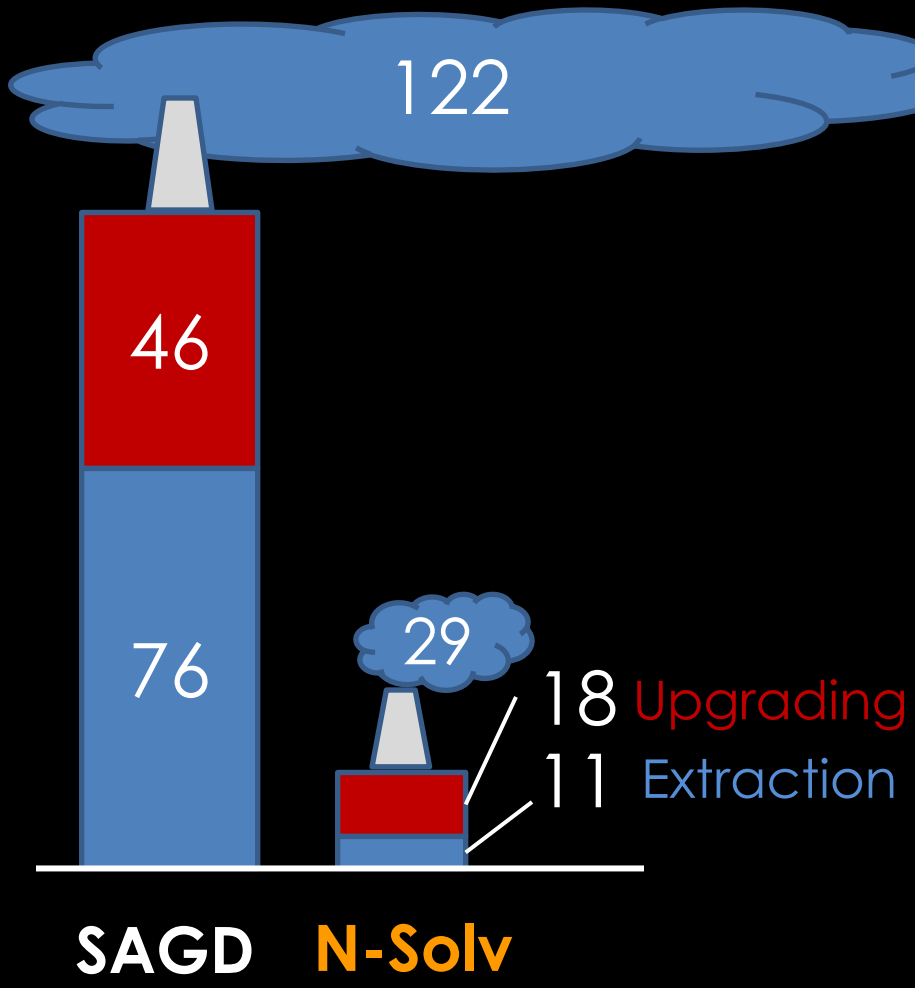
n-solv Corporation

cleaner energy

N-Solv Environmental

Well to Tank: GHG Emissions

n-solv Corporation
cleaner energy

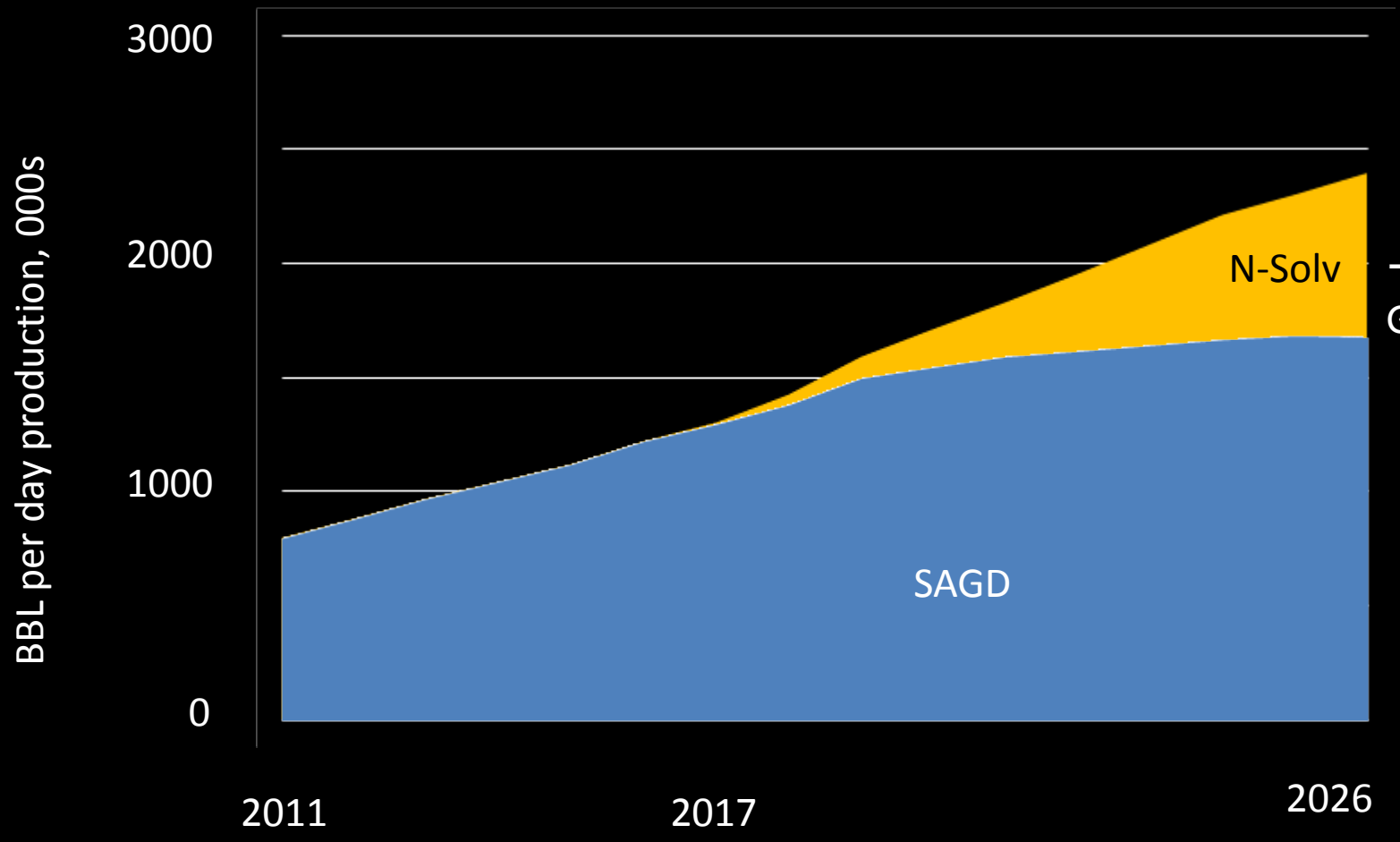


93kg CO_2e reduction per barrel

n-solv Corporation

cleaner energy

N-Solv Rollout

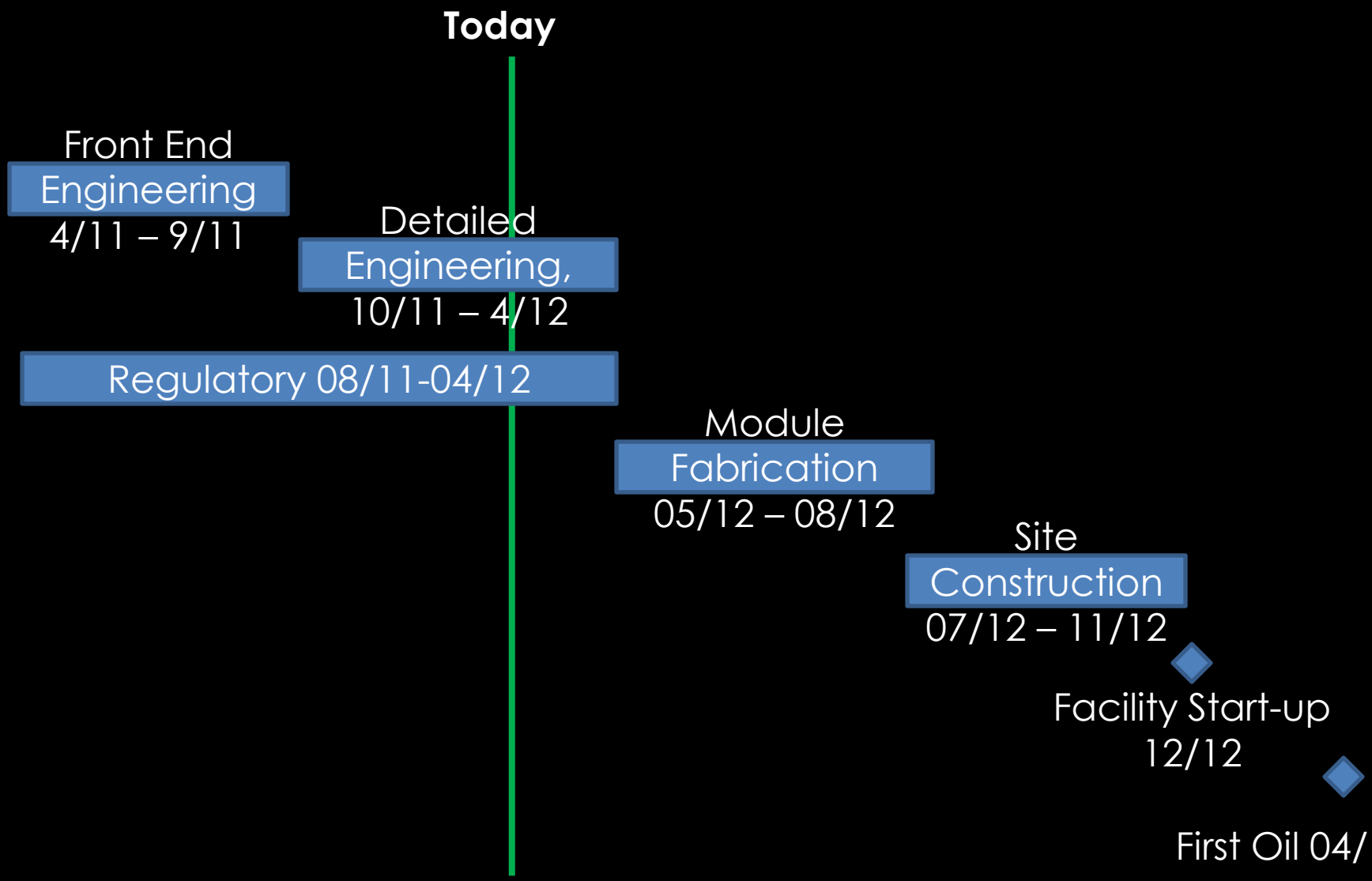


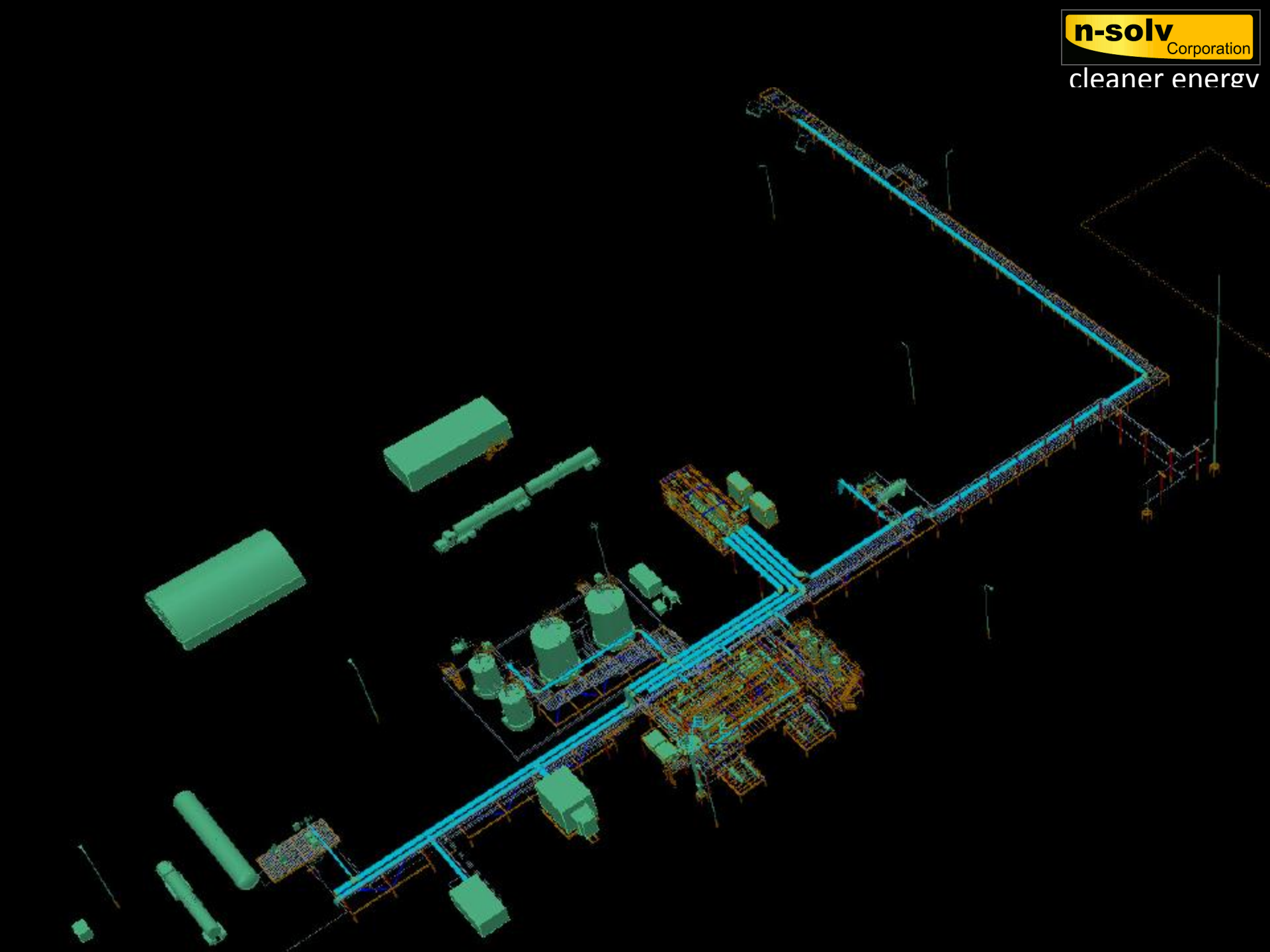
→ 110 MT of GHG reductions

Status: Pilot

Time to First Oil

n-solv Corporation
cleaner energy




n-solv
Corporation
cleaner energy

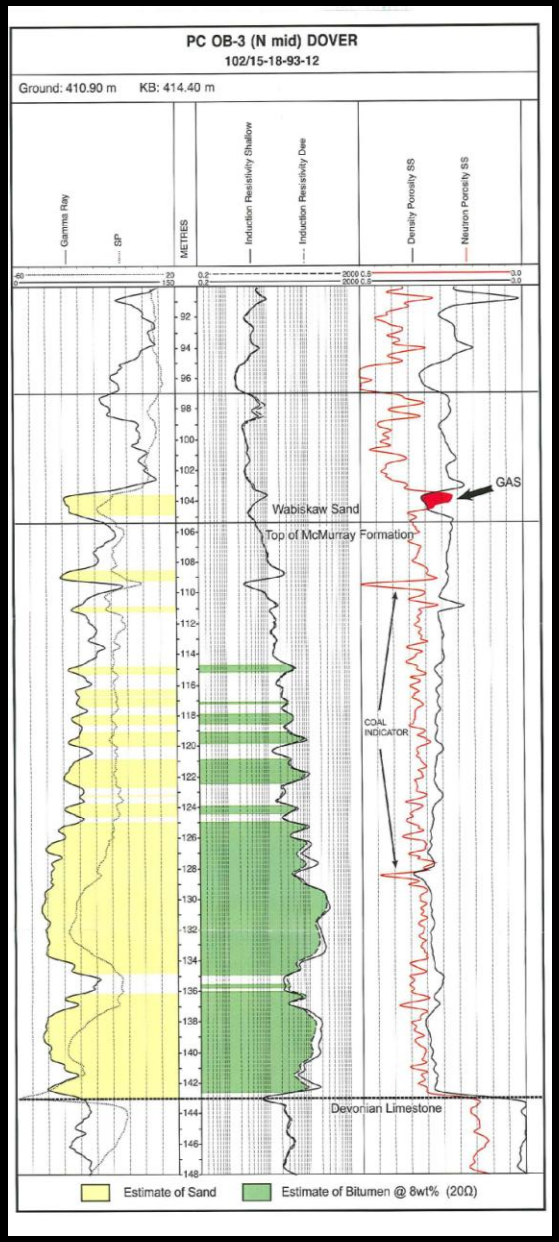
Subsurface Status

n-solv Corporation
cleaner energy

- Horizontal Wells
  - Designs complete
  - Subsurface lift system and instrumentation specified
  - Start-up models and hydraulic studies complete

Reservoir

n-solv Corporation
cleaner energy



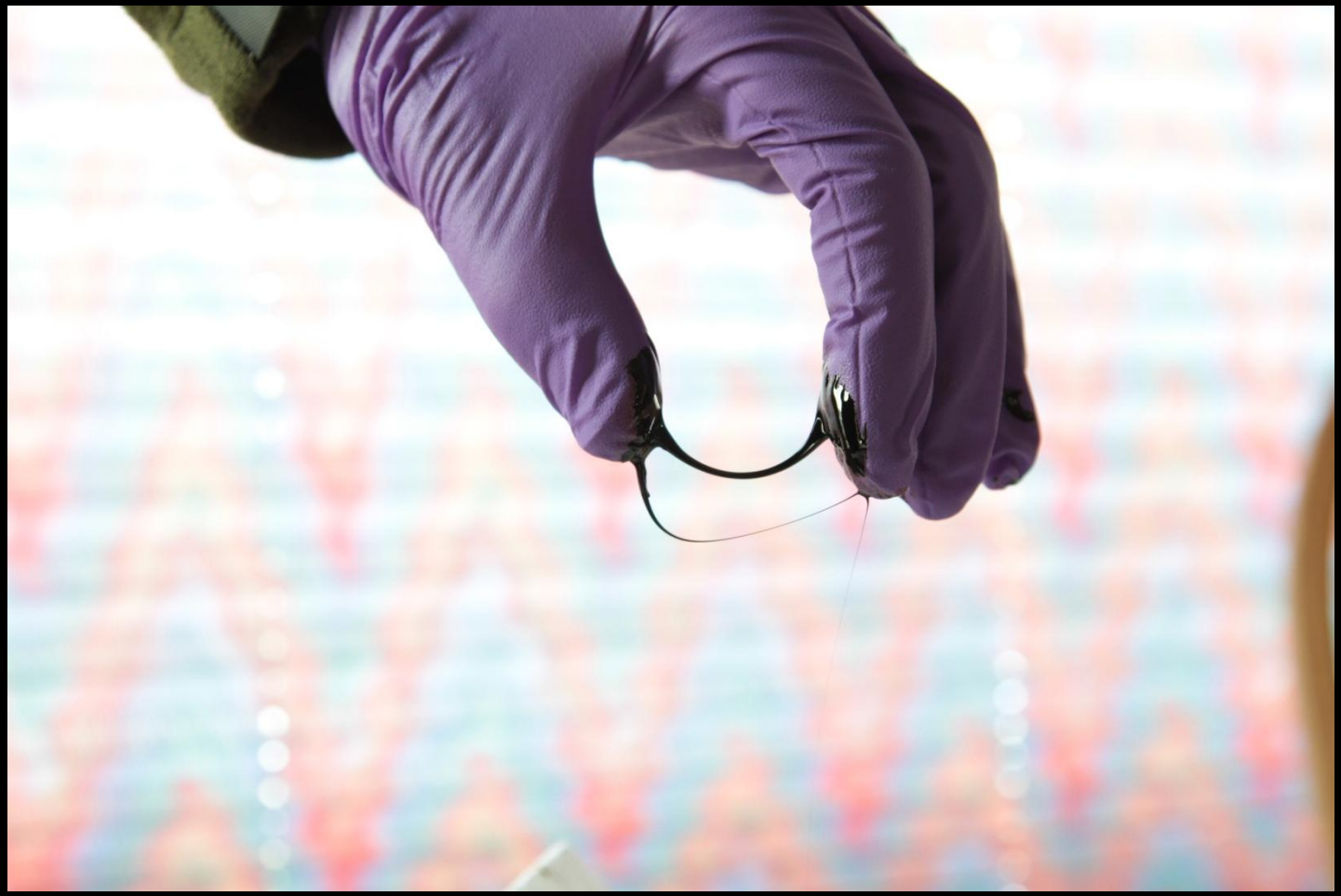
n-solv Corporation

cleaner energy

The Science

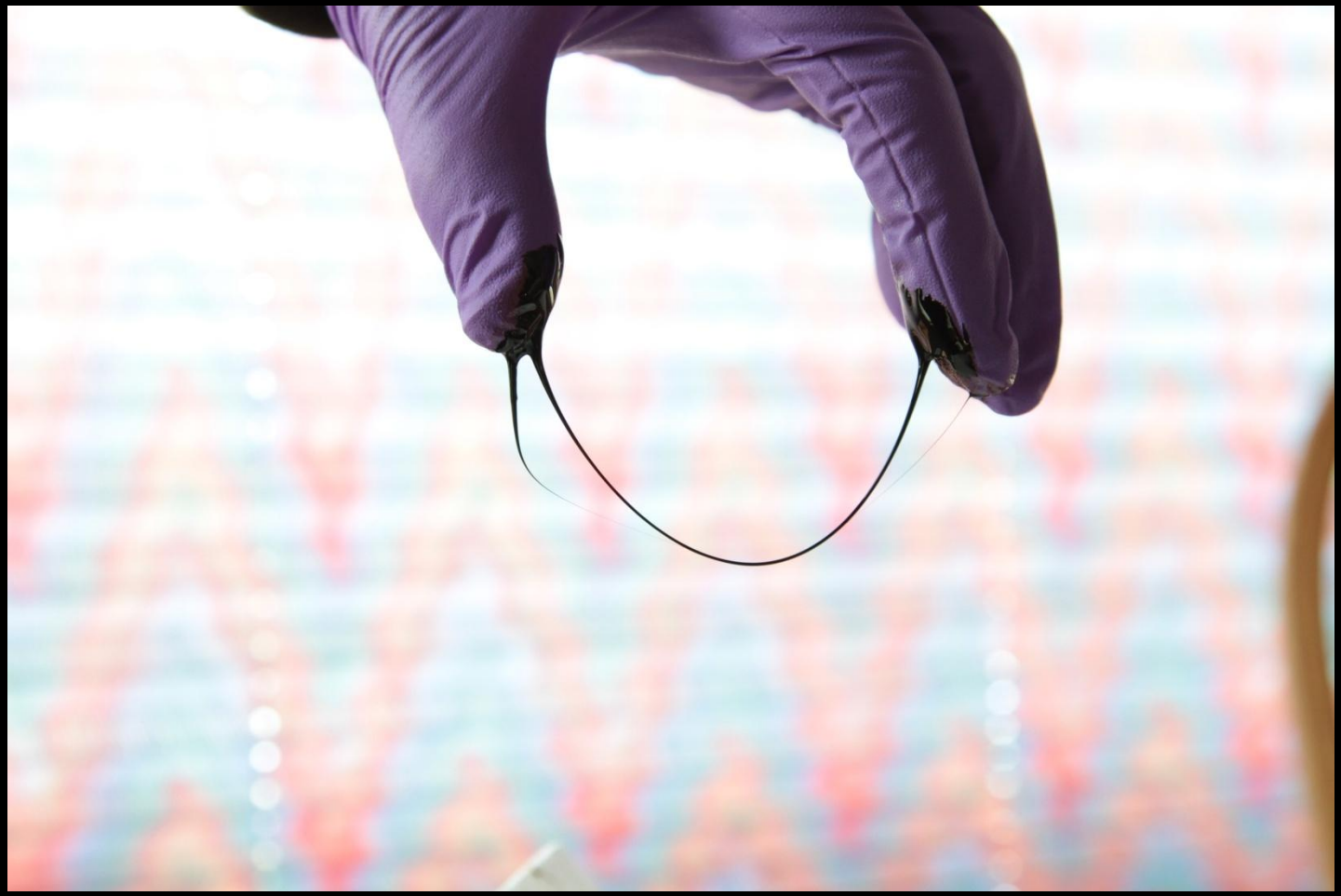
n-solv Corporation

cleaner energy



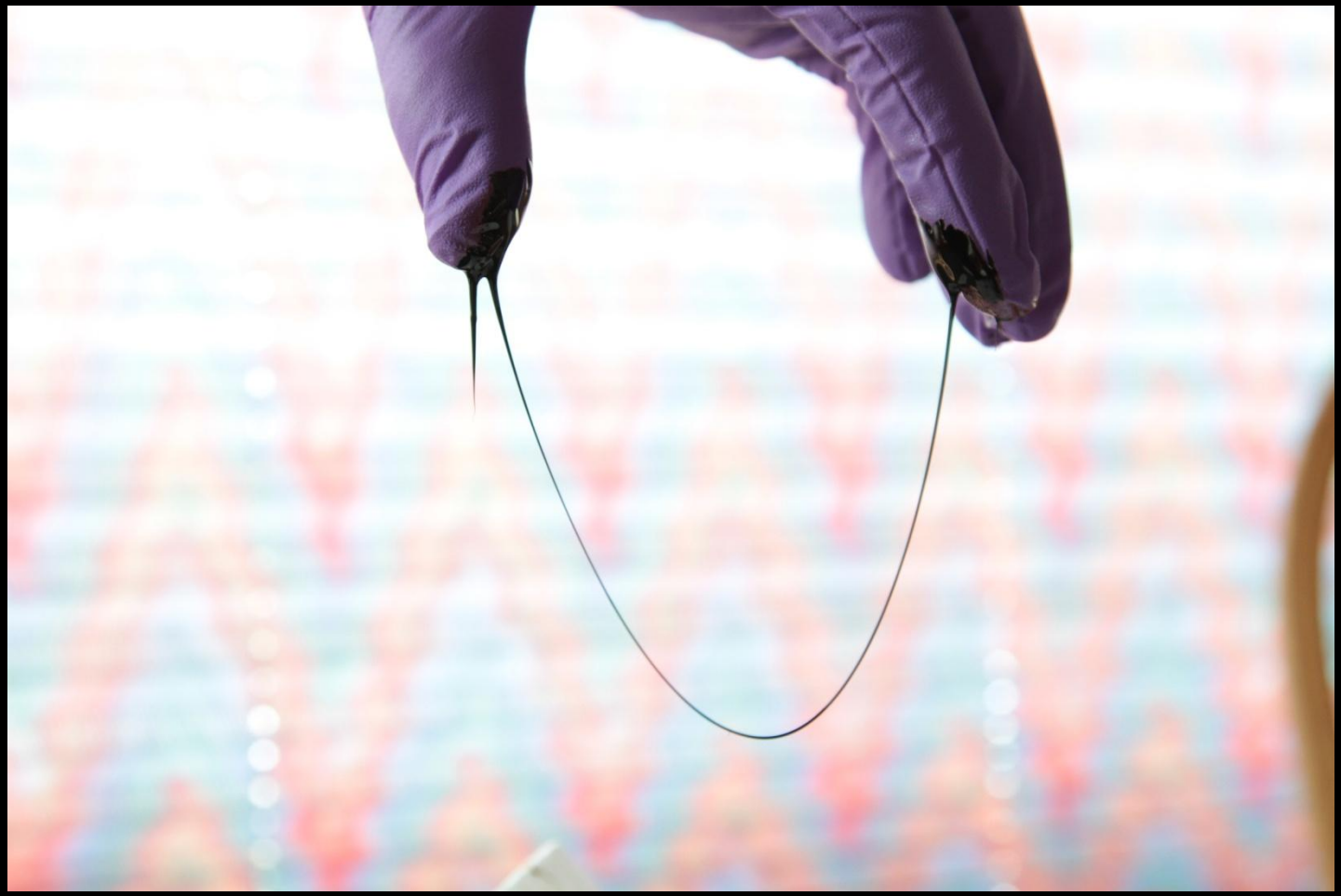
n-solv Corporation

cleaner energy



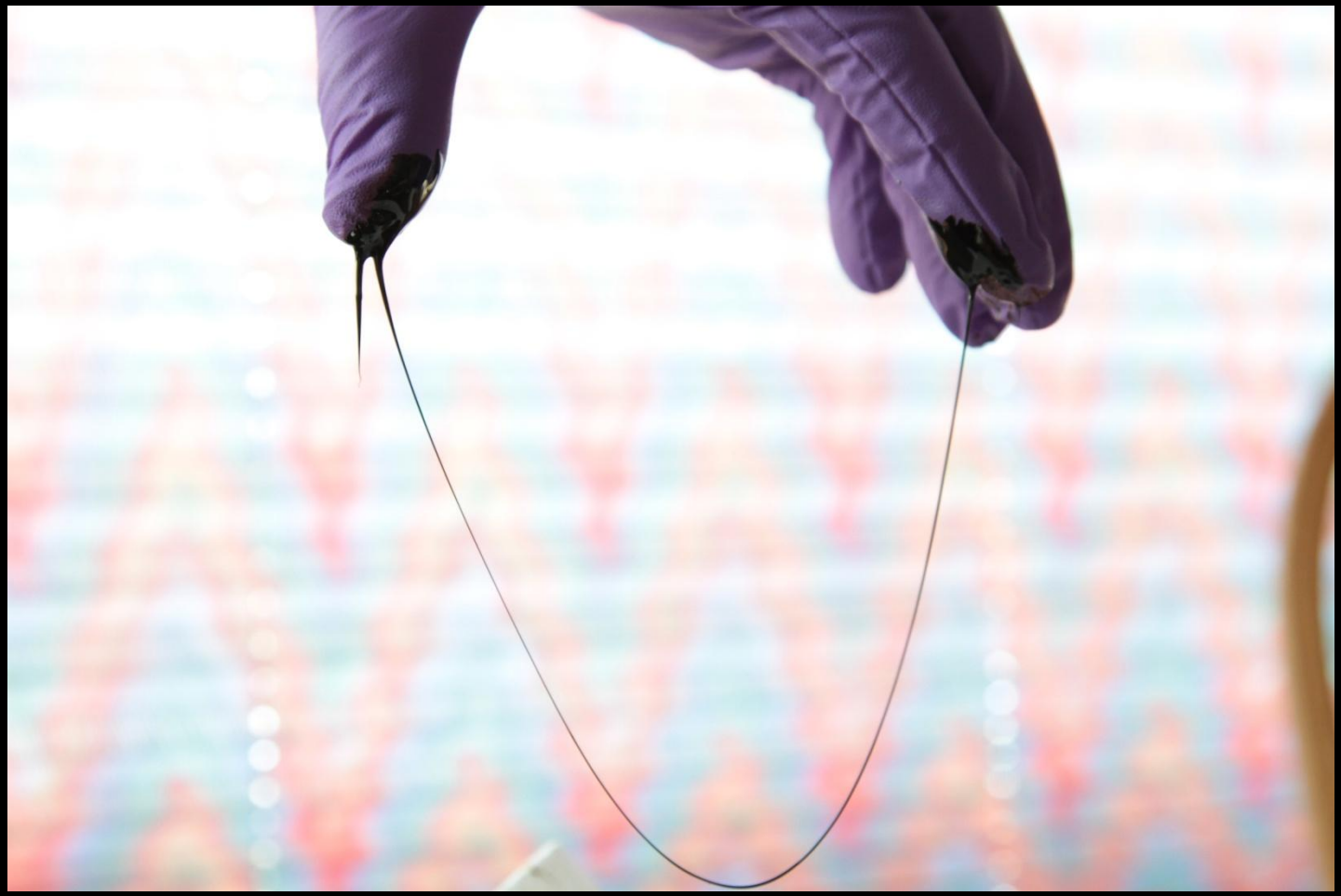
n-solv Corporation

cleaner energy



n-solv Corporation
cleaner energy

Oil or Tar or ??



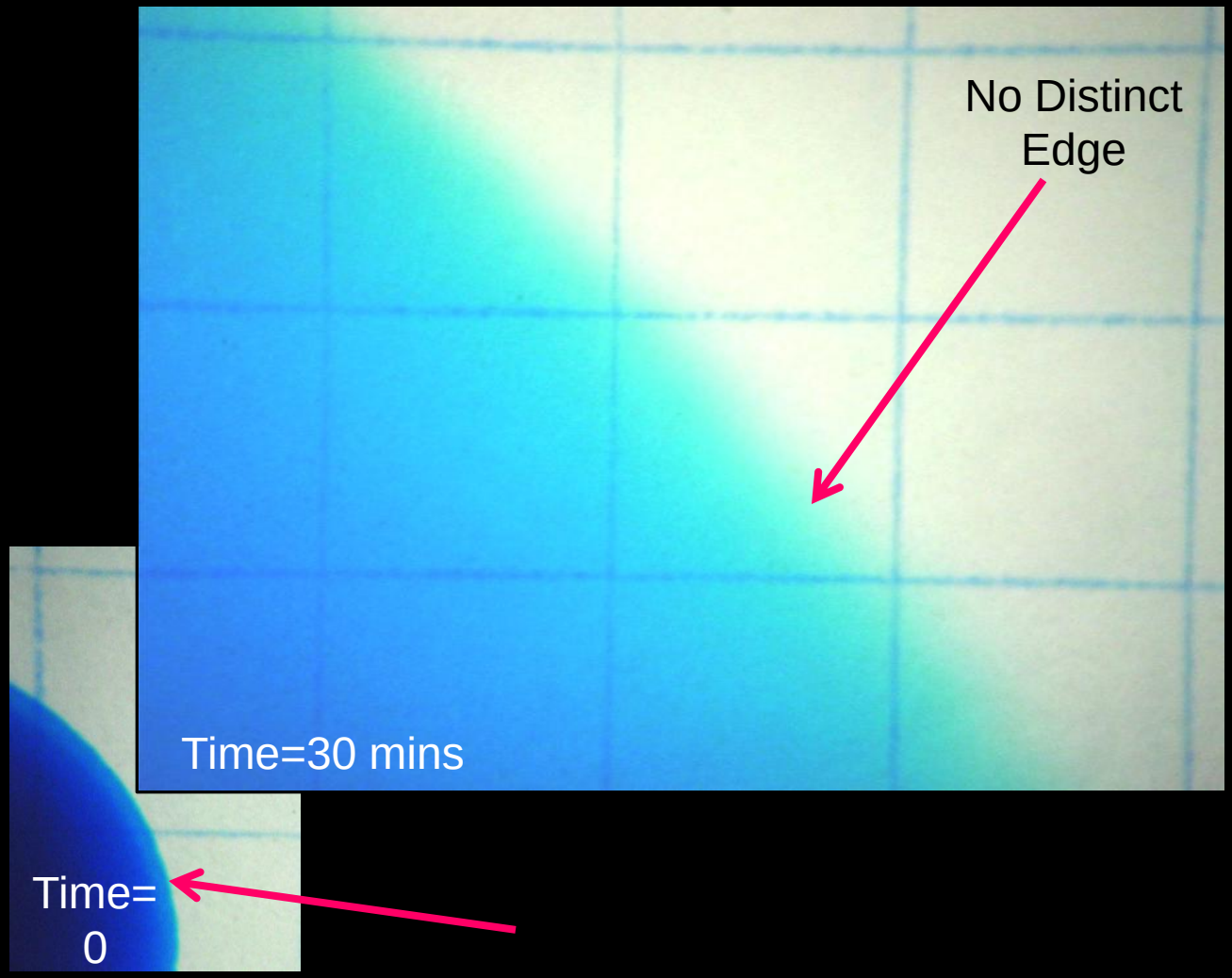
Liquid-Liquid Diffusion

n-solv Corporation
cleaner energy

Sharp
Edge

Liquid-Liquid Diffusion

n-solv Corporation
cleaner energy



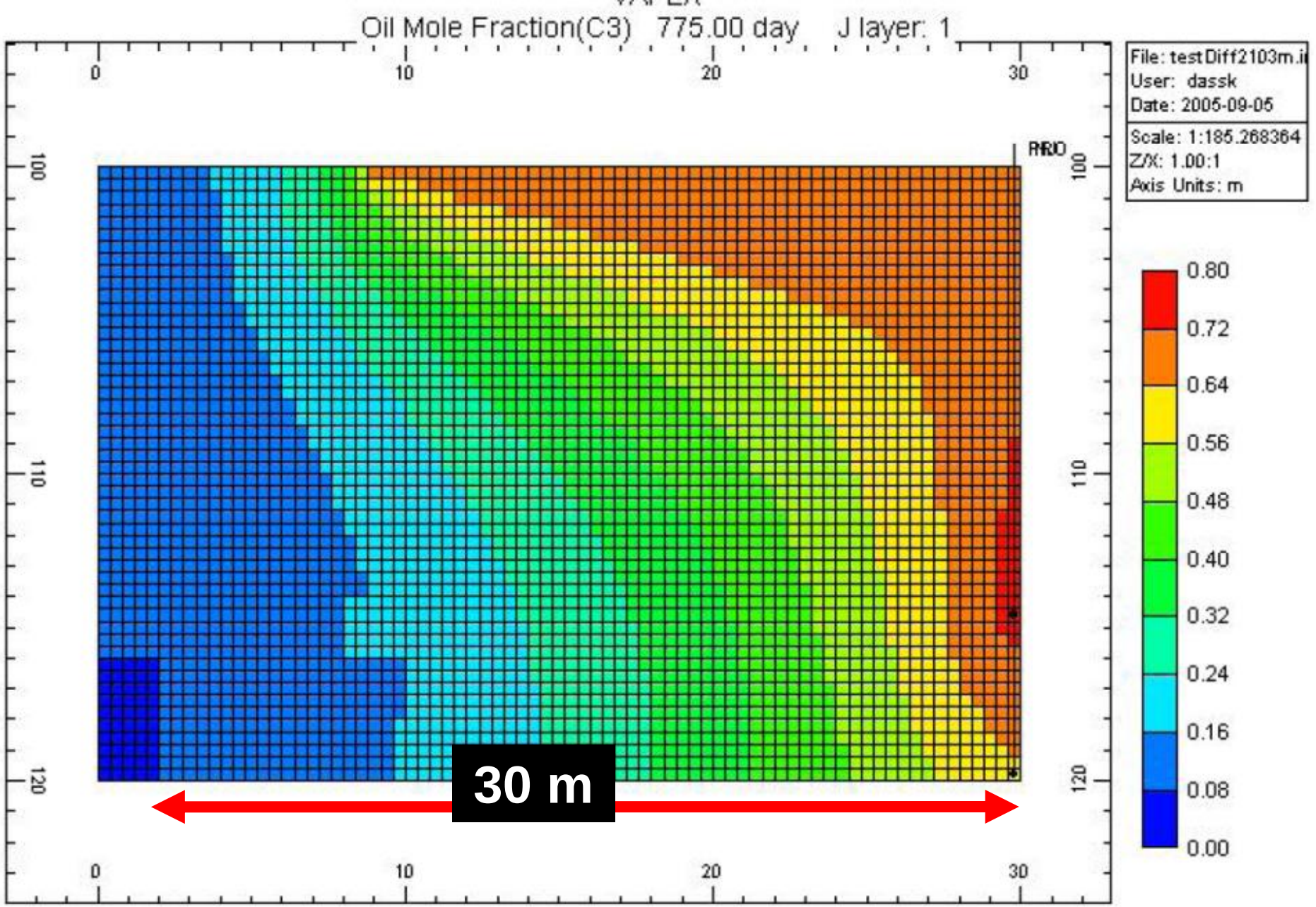


Figure 6. Propane concentration in bitumen at 775 d.

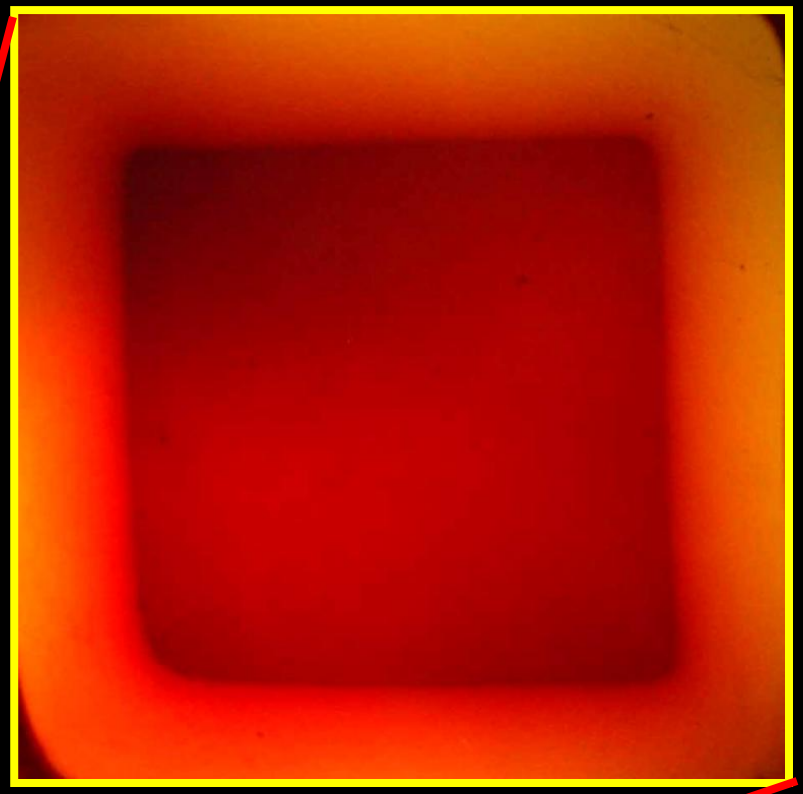
Dissolution of Bitumen

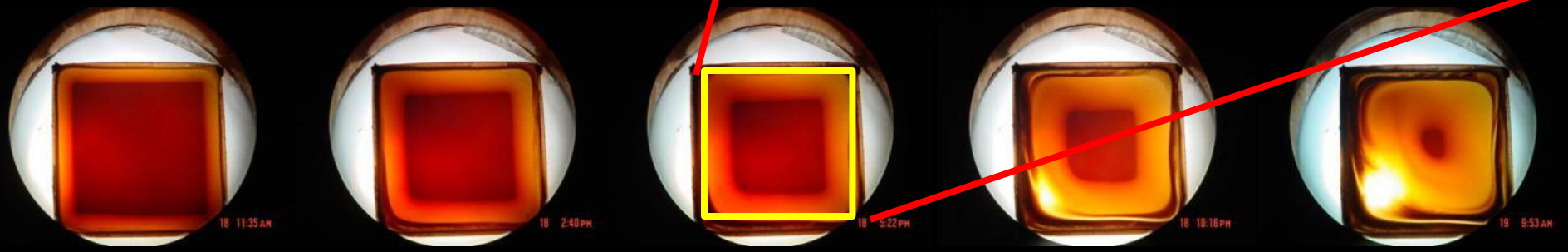
n-solv Corporation
cleaner energy

- Time series showing a layer of bitumen sandwiched between 2 glass slides and submerged in hexane solvent

➔ **Looks like an ice cube melting**

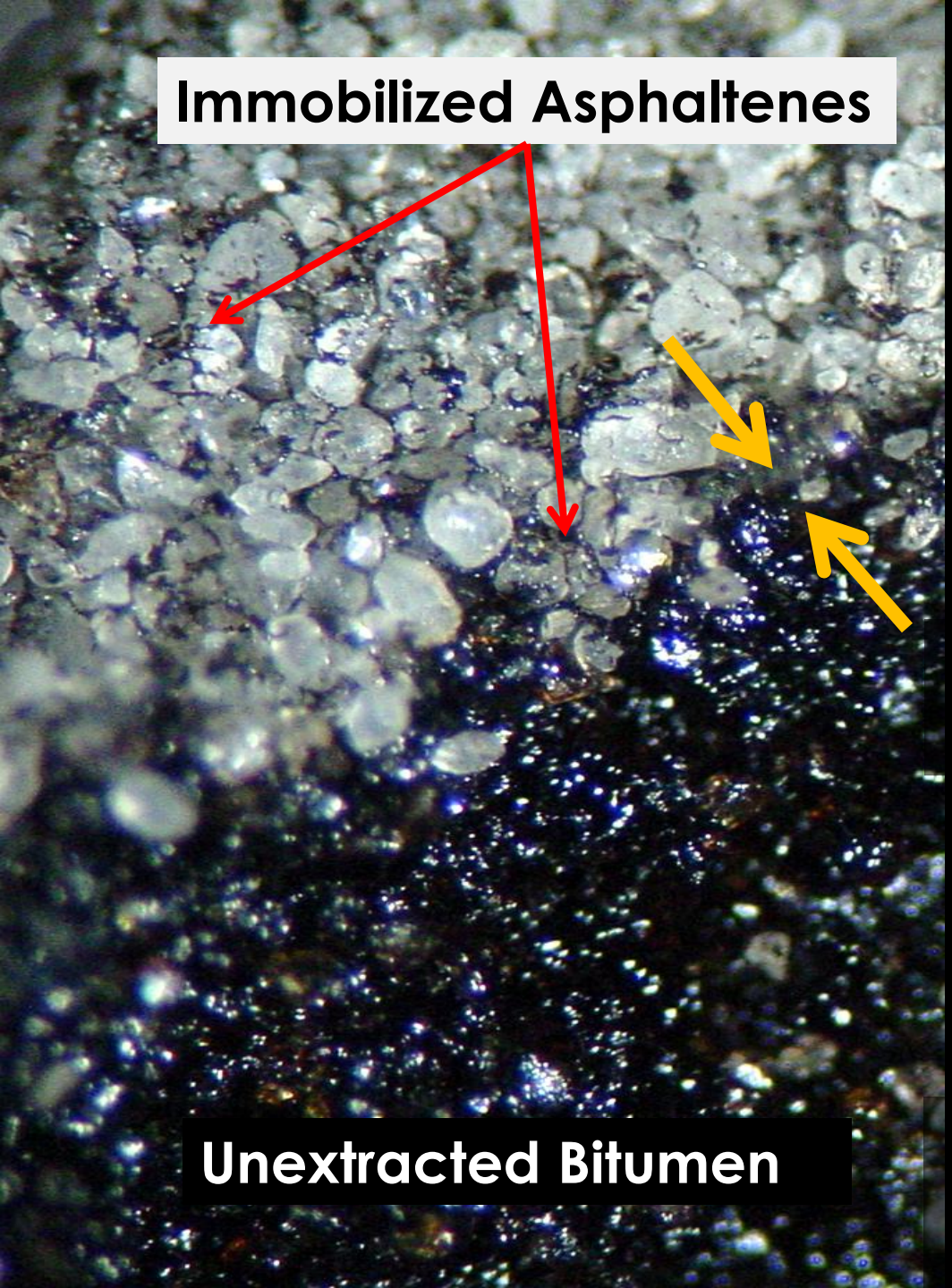
➔ **Dissolution is confined to a very thin zone (200 µm)**





Increasing Time (24 hour interval) ➔

From Nenniger and Dunn, "How fast is solvent based gravity drainage? "CIPC paper 2008-139



n-solv Corporation
cleaner energy

shock front is about
100 µm deep

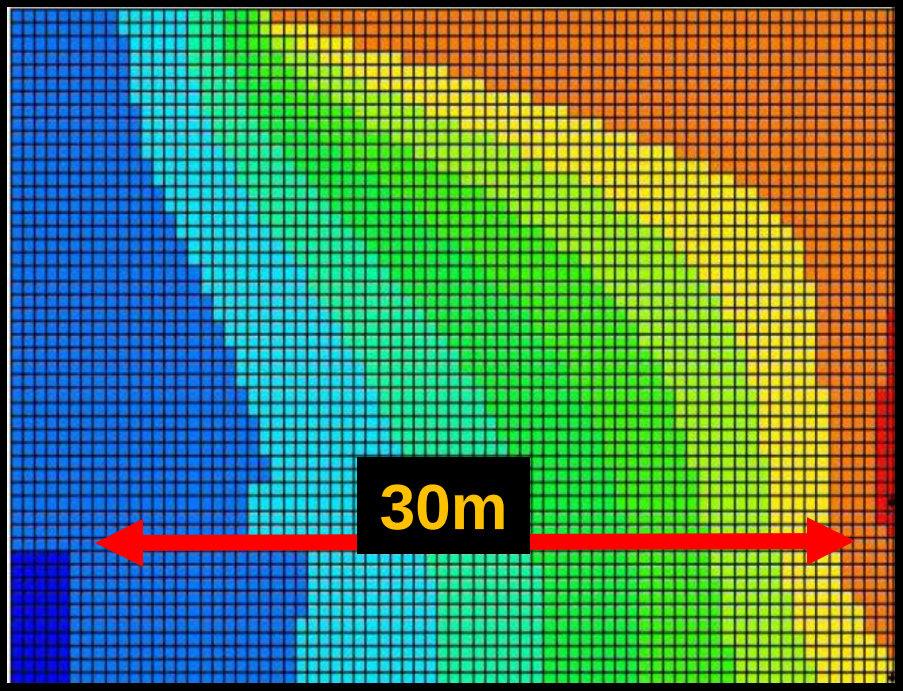
An N-Solv experiment showing the interface between extracted and the un-extracted zones

Why Fuss?

- Reservoir model **predict** solvent penetrates 30m into bitumen
- N-Solv lab study measured 0.0001m

➔**300,000 fold discrepancy**

- **Significance?**

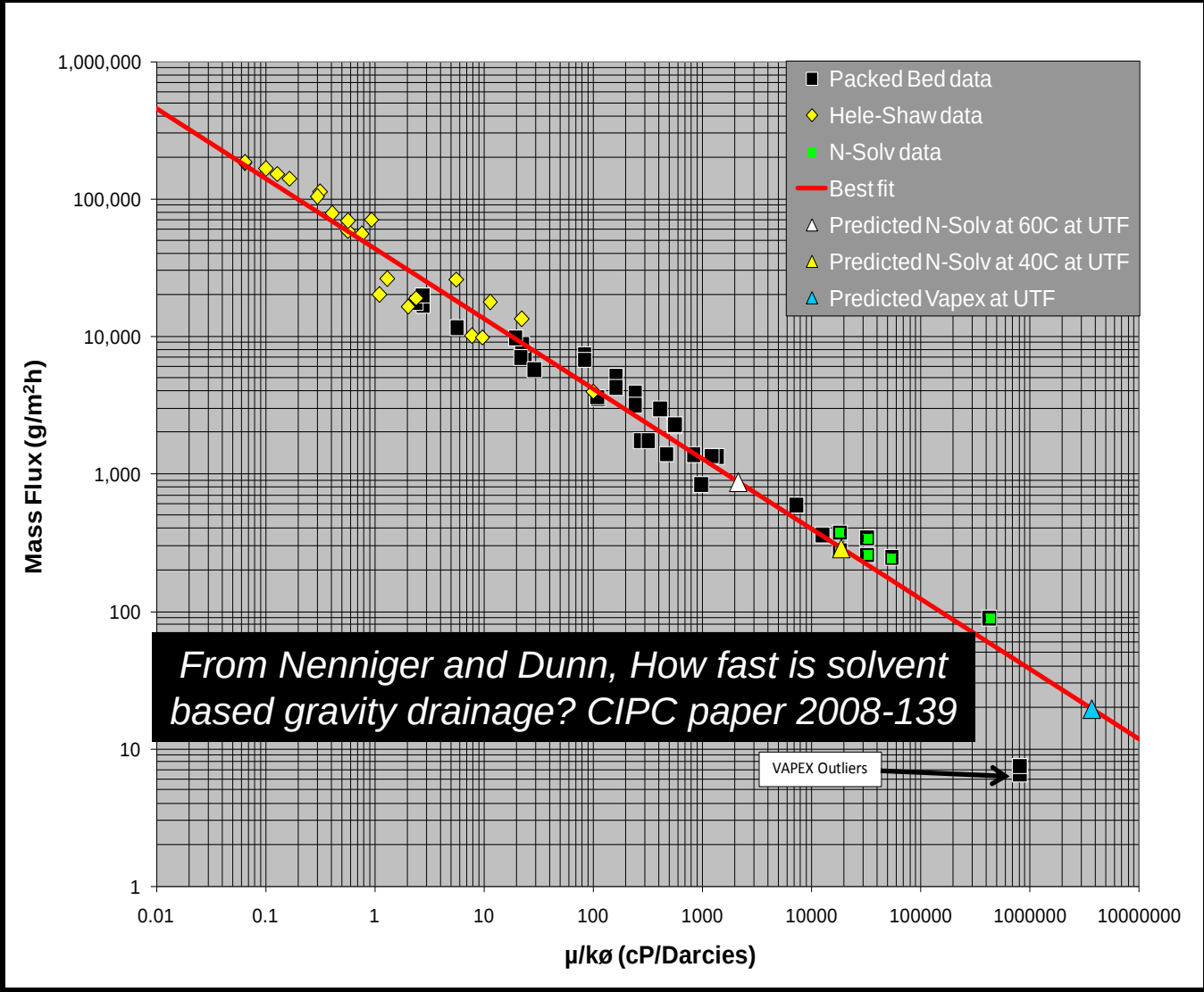


Solvent Based Gravity Drainage

n-solv Corporation
cleaner energy

- Extraction rate is controlled by the bitumen viscosity
- 30C temperature rise drops bitumen viscosity by 100 fold

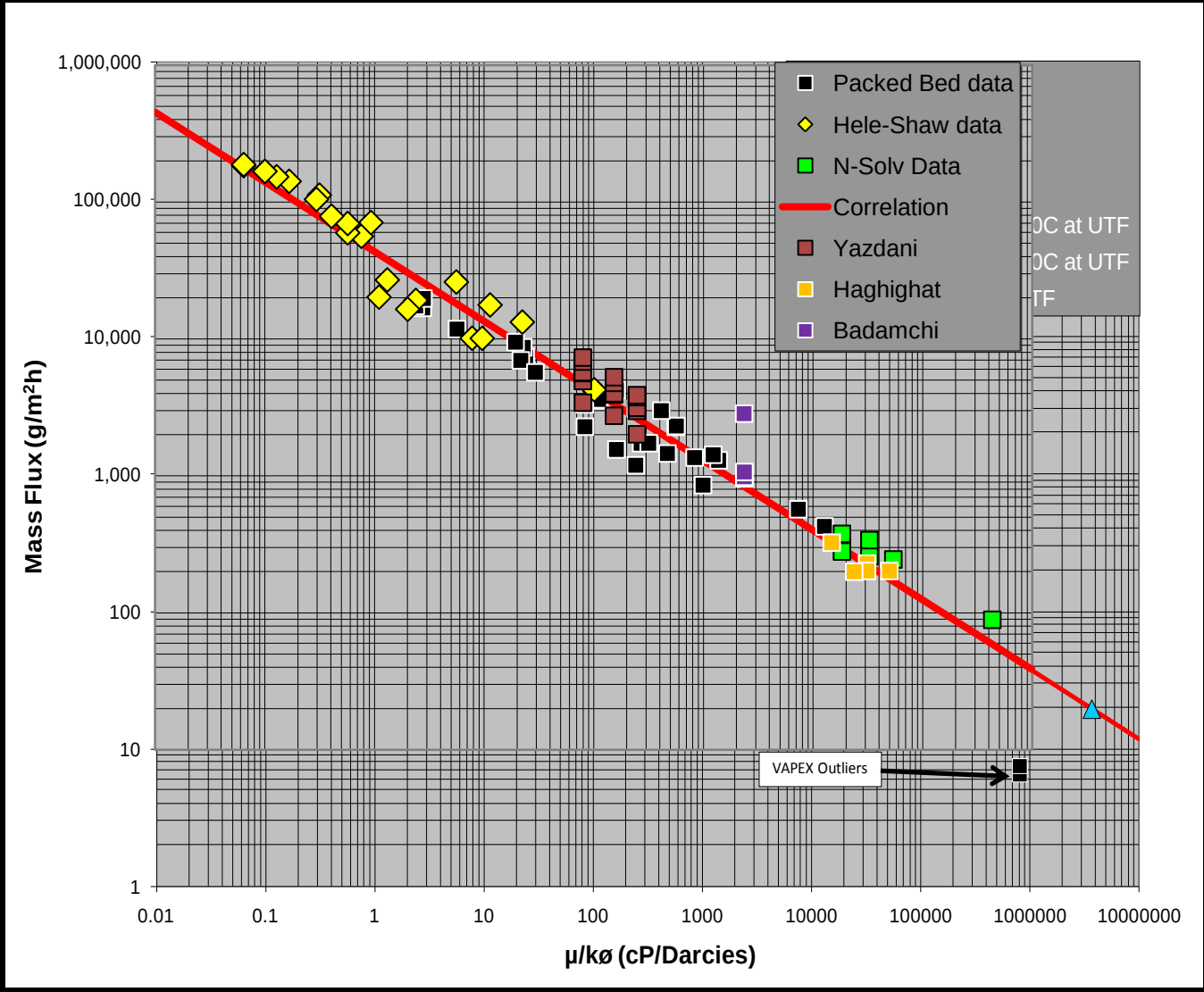
➔ Can achieve SAGD rates with 1/8th of the energy or GHG requirement



Solvent Based Gravity Drainage

n-solv Corporation
cleaner energy

- Since we published our correlation in 2008, the amount of experimental data has almost doubled
- **New data supports the correlation**



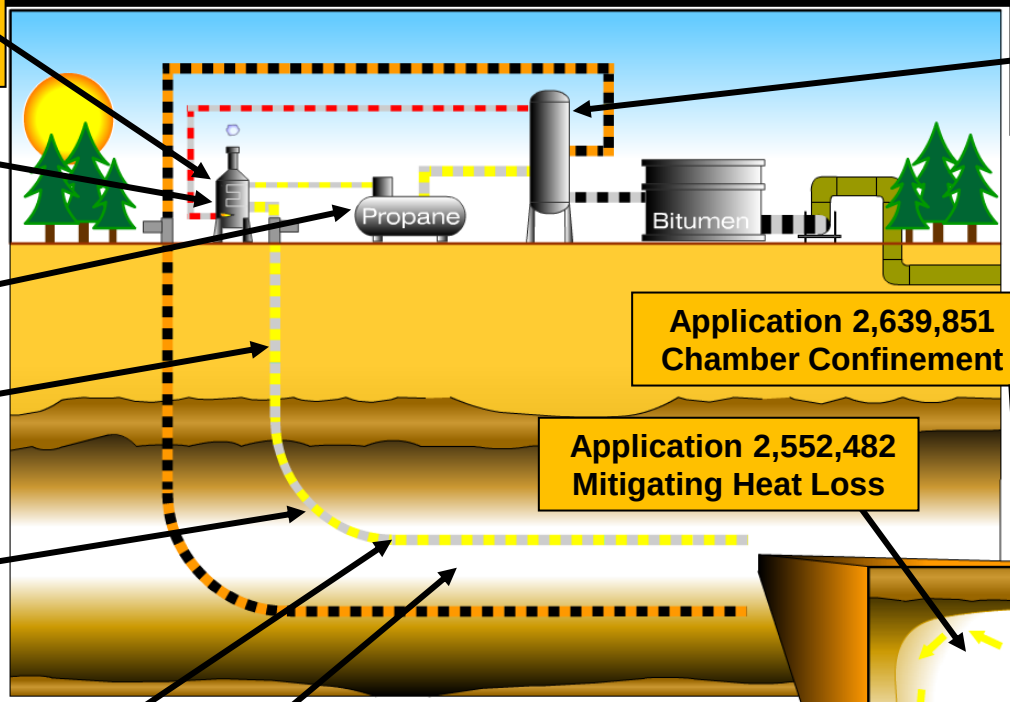
n-solv Corporation
cleaner energy

Commercialization

Intellectual Property

n-solv Corporation
cleaner energy

» ~ 400 IP claims directed towards energy efficient in situ extraction



Patent 2,374,115 Use of Waste Heat including co-gen

Patent 2,374,115 Use of geothermal heat

Patent 2,591,354 Alternative Solvents

Patent 2,299,790 Latent Heat

Patent 2,351,148 Solvent Purity Spec

Patents 2,235,085; 2,567,399 Downhole Electrical Heat

Patents 2,235,085; 2,567,399 Heater for Start-up

Patent 2,351,148 Solvent Purification and Recycling

Application 2,639,851 Chamber Confinement

Application 2,639,851 Chamber Conformance

Application 2,552,482 Mitigating Heat Loss

Application 2,552,482 Removing Non-condensables

Patent 2,436,158 Exptl Apparatus

Patent 2,351,148 US Patents 6,883,607; 7,363,973 Continuous Condensing Conditions

Patent 2,591,354 CCS using COS

Patent 2,299,790 Energy Efficient Temperatures

Patent 2,299,790 Pressure Control to Achieve Temperature Control

Stranded Bitumen

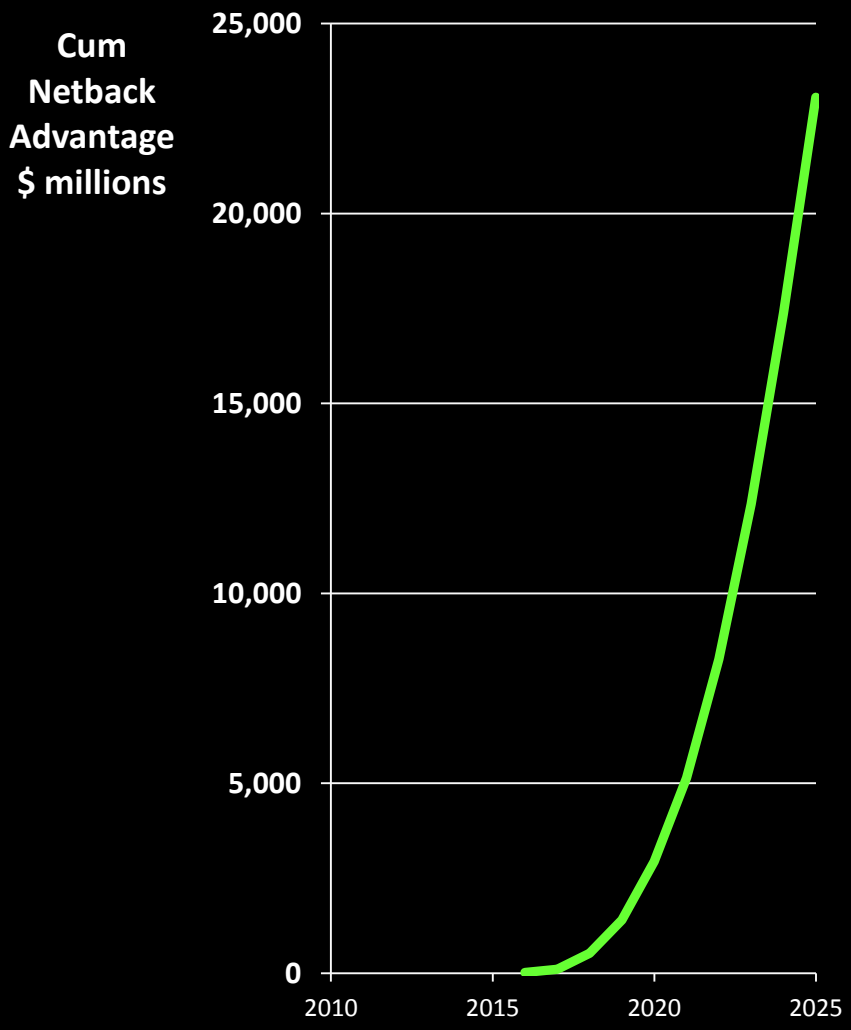
n-solv Corporation
cleaner energy

Resource	Billions of bbls	Why
No-Man's Land	600	Pressure too low for SAGD
Carbonates	536	Steam/oil ratio too high
Thin Zones	200+	Steam/oil ratio too high
GOB, WOB	???	Cap rock is too fragile for steam induced stresses
Total Stranded Resources	**1,300+**	

Commercialization

n-solv Corporation
cleaner energy

- With a modest market share, the cumulative value add for N-Solv grows rapidly;
- Multiple commercialization options



Summary

n-solv Corporation
cleaner energy

- N-Solv offers
  - Strong corporate backing
  - Breakthrough science and technology
  - Twice the netback of SAGD
  - Three times the profit/investment ratio of SAGD
  - Substantive incremental reserves
  - 93^{+}kg/bbl reduction in GHG intensity
  - No water consumption
  - Understated economics

n-solv Corporation

cleaner energy

403-397-1282

801-6th Ave SW, Suite 2300
Calgary, AB
N-Solv.com

Price Elasticity

n-solv Corporation
cleaner energy

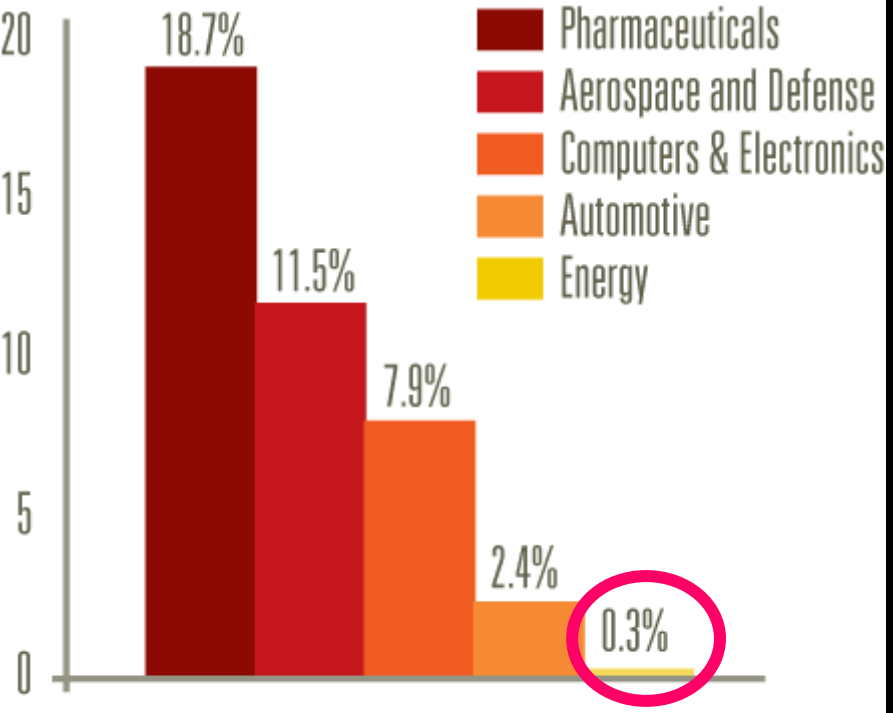
- How does an oil surplus or deficit affect prices?
  - A civil war in Libya removes 1 million bopd and oil prices will rise $10/bbl
  - 1 million bopd of new supply (Oilsands, Bakken) will drop oil prices by $10/bbl
- 1 million bopd of new oil reduces the oil cost for US consumers by $200million/day (20mbopd x $10/bbl)
- **A barrel of new oil supply, produced anywhere in the world and sold anywhere in the world saves US consumers $200!**

n-solv Corporation
cleaner energy

Conservation vs New Supply?

- Every barrel saved via conservation saves US consumers $300 = 100 cost + 200 from price elasticity
- If a barrel of oil costs $100, the net benefit of any new supply is +$100/bbl = -100 + 200
- New oil supply is “free money” for consumers, but conservation is **really big bucks**

R&D Spending as a Share of Sales

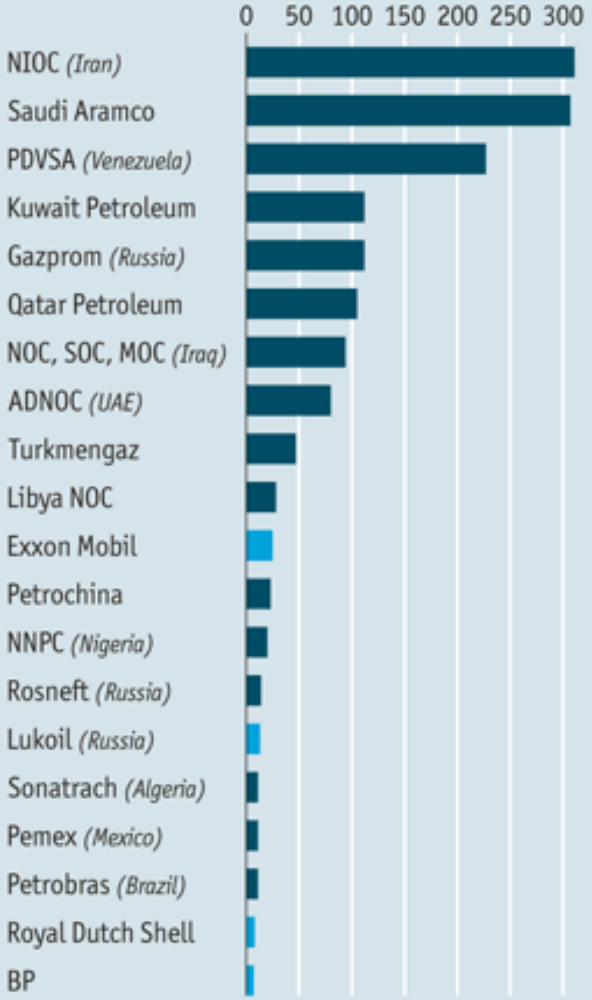


Of all major technology-dependent sectors, the energy sector spends the smallest portion of its sales on research and development. [1]

Little Exxon, tiny Shell

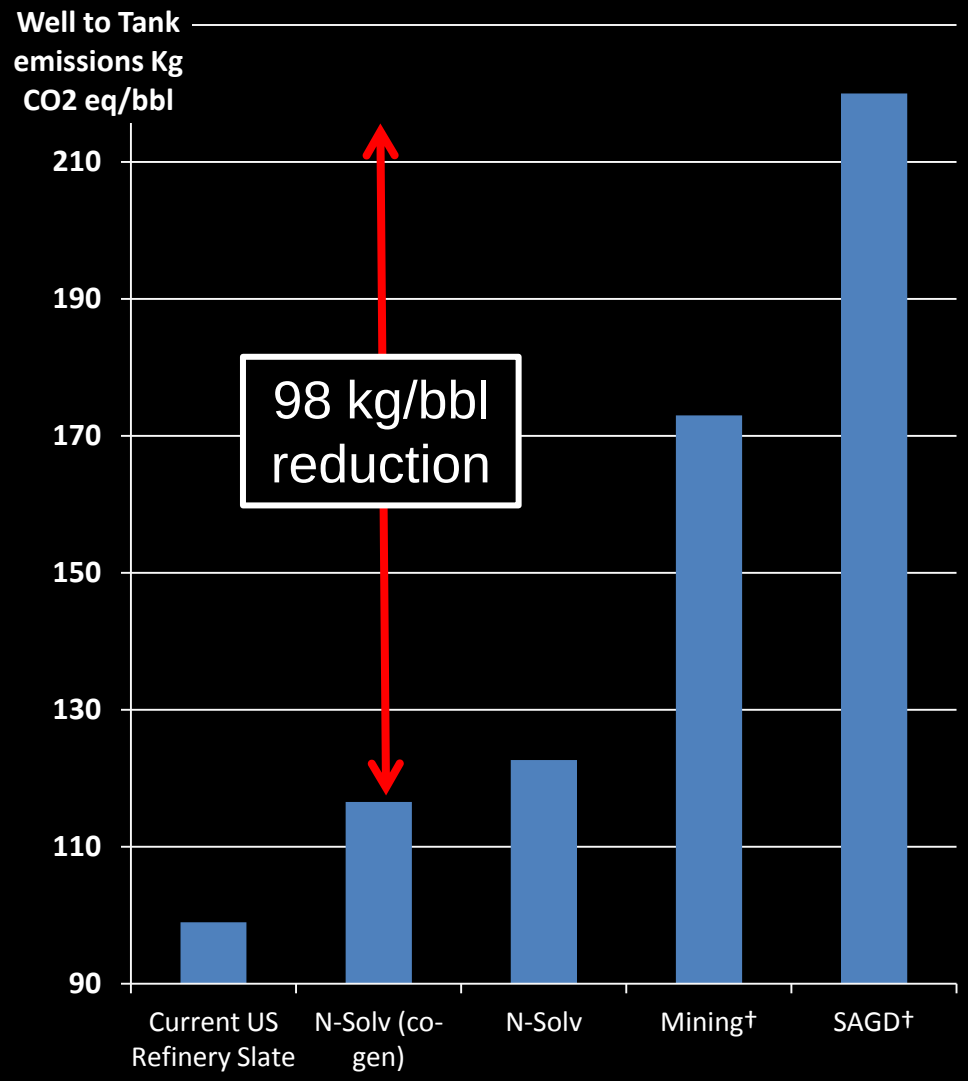
Proven oil and gas reserves, 2010

Billion barrels of oil equivalent



Sources: Oliver Wyman; *The Economist*

n-solv Corporation
cleaner energy

EPA GHG Criteria

- EPA assesses transportation fuel using a well to tank criteria (WTT)
- Current refinery slate in the US has WTT emissions of 99kg CO_2eq/bbl
- AERI/Jacobs Lifecycle Study reports SAGD WTT is 218 kg/bbl
- Mining WTT is 173kg/bbl
- N-Solv WTT is estimated to be 125 kg/bbl with opportunities (co-gen) for improvement