Reducing freshwater in hydraulic fracturing: An analysis of fracturing fluids used in the Montney Formation in Alberta and policy recommendations for freshwater reduction

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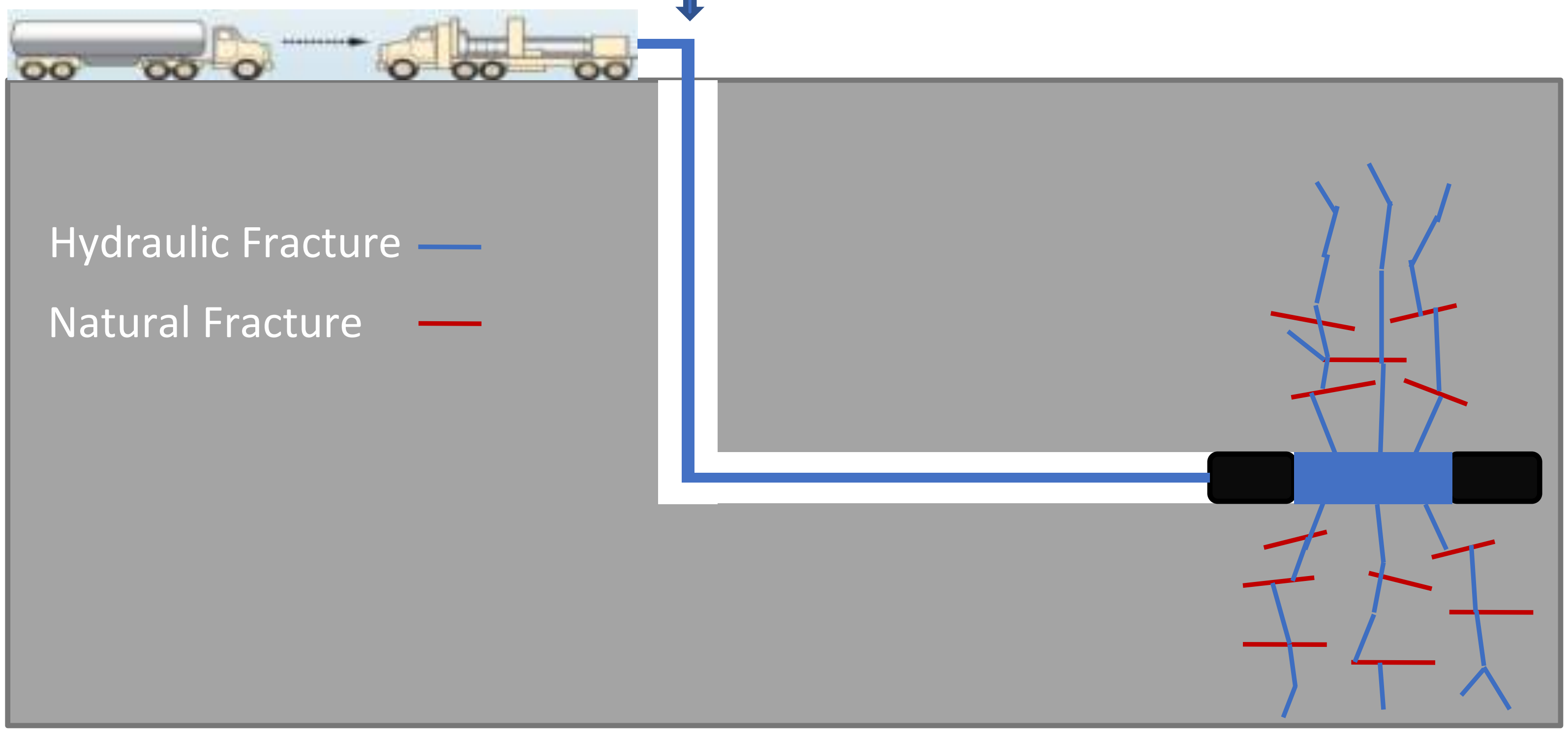
ReDeveLoP Conference, Hilton - Calgary, Alberta

May 26-31

Hydraulic Fracturing

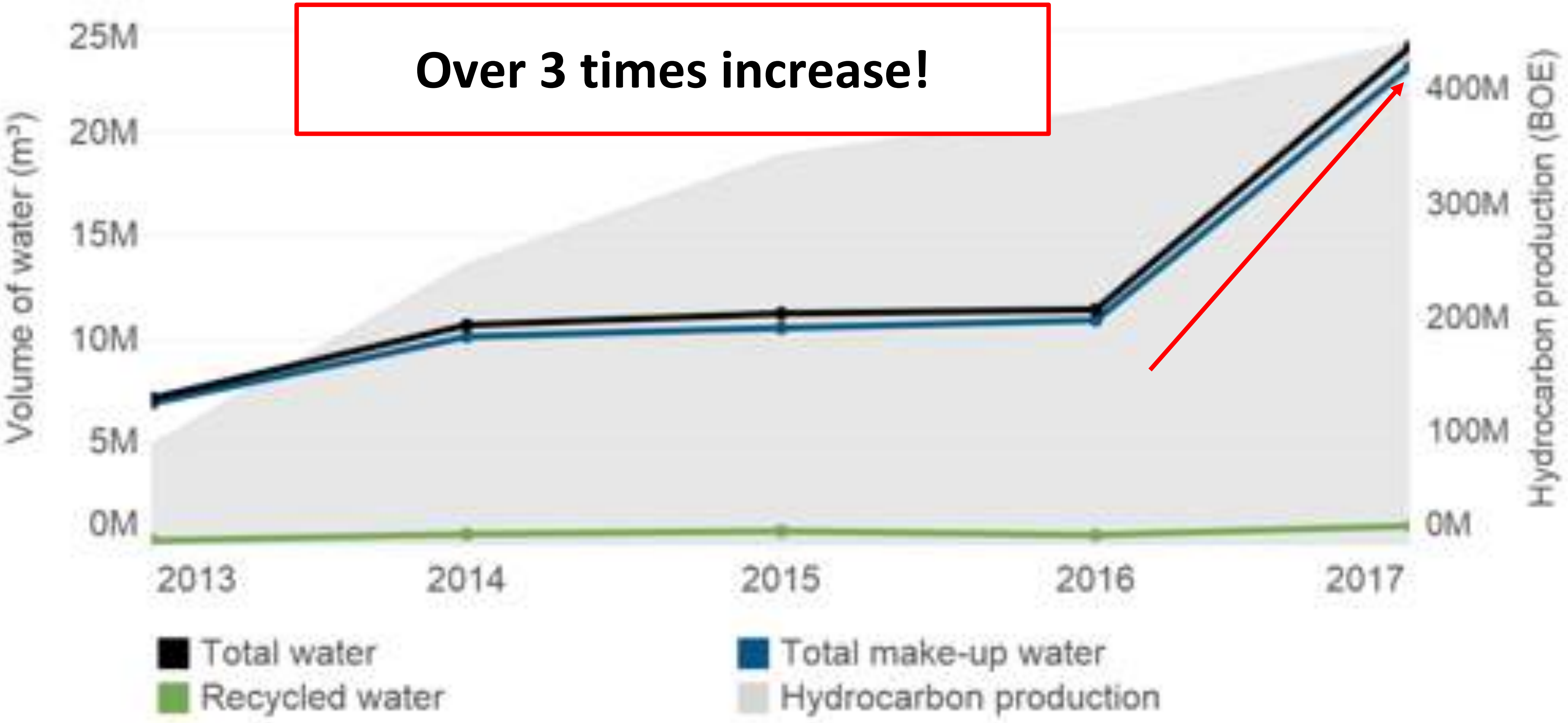
Injecting the mix of sand, chemical additives & water into well

Water Tanks



To create fractures & ease production from unconventional resources

Problem: Water-Intensive Process



Source: AER (2017)

Potential Negative Impacts

Water
contamination

Impacts
on aquatic ecosystems

Disturbing water
cycle

Quality and availability
of potable water

Hydraulic Fracturing Fluids (HFF)

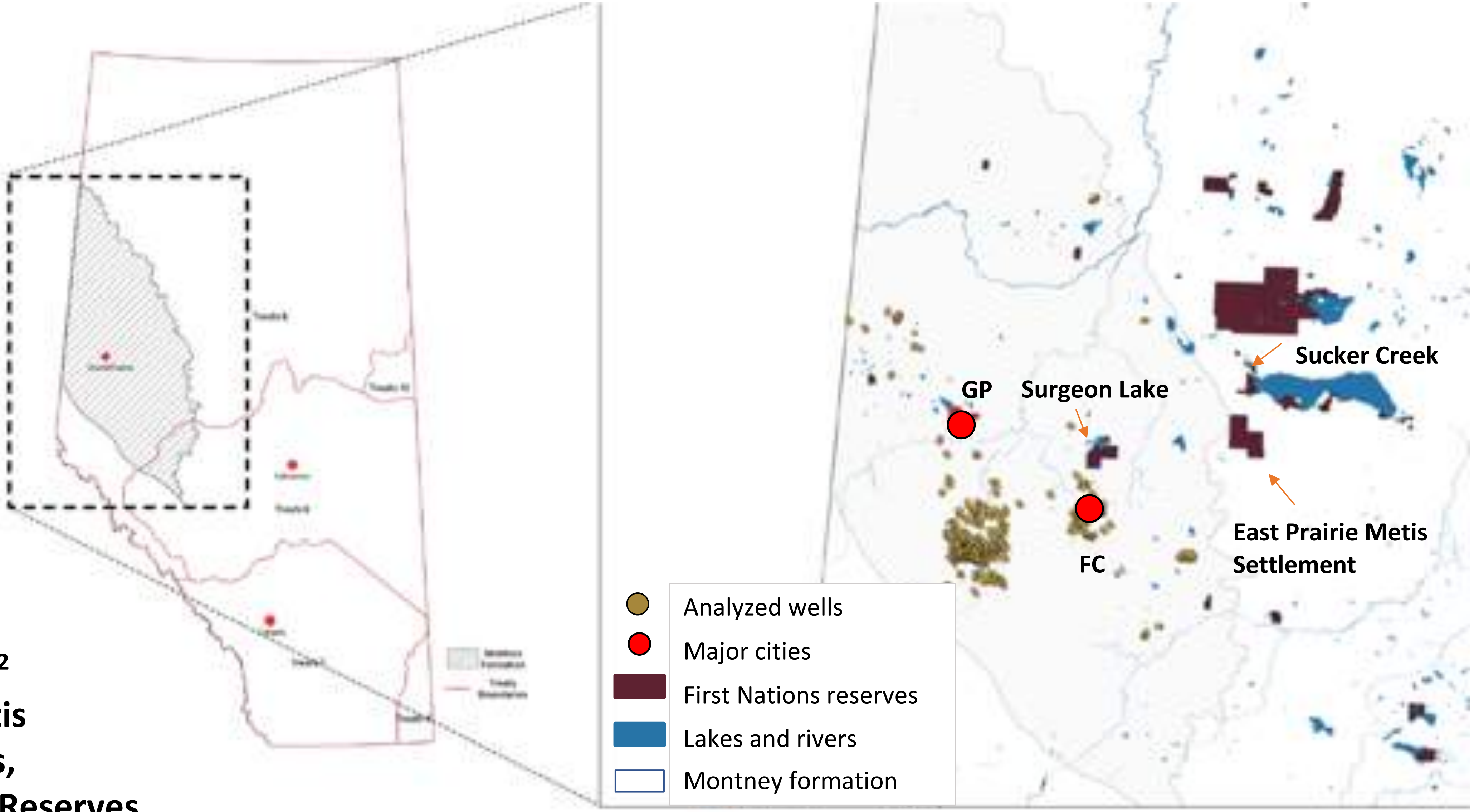
FLUID TYPE	PRIMARY CARRIER FLUID	CONCENTRATION IN HFF BY % MASS OF PRIMARY CARRIER FLUID	ENERGIZING FLUID
WATER-BASED	Water	along with proppant >99%	None
ENERGIZED – CRYOGENIC	Water	26 - 65%	Liquefied Nitrogen (N_2) or Carbon Dioxide (CO_2)
ENERGIZED – GAS	Water	27 - 57%	Nitrogen (N_2)
OIL-BASED	Crude Oil, Kerosene, Diesel, Liquid Petroleum Gas (LPG), Propane	>55%	None

ReDeveLop Hydraulic Fracturing Freshwater Challenge

HFF – Comparison

	Water-based	Energized-cryogenic	Energized-Gas	Oil-based
High formation damage				
High water use				
High proppant capacity				
High recovery rates				
High cost				
Fast clean-up				
Complex fractures				

Area of Study: The Montney Formation, AB



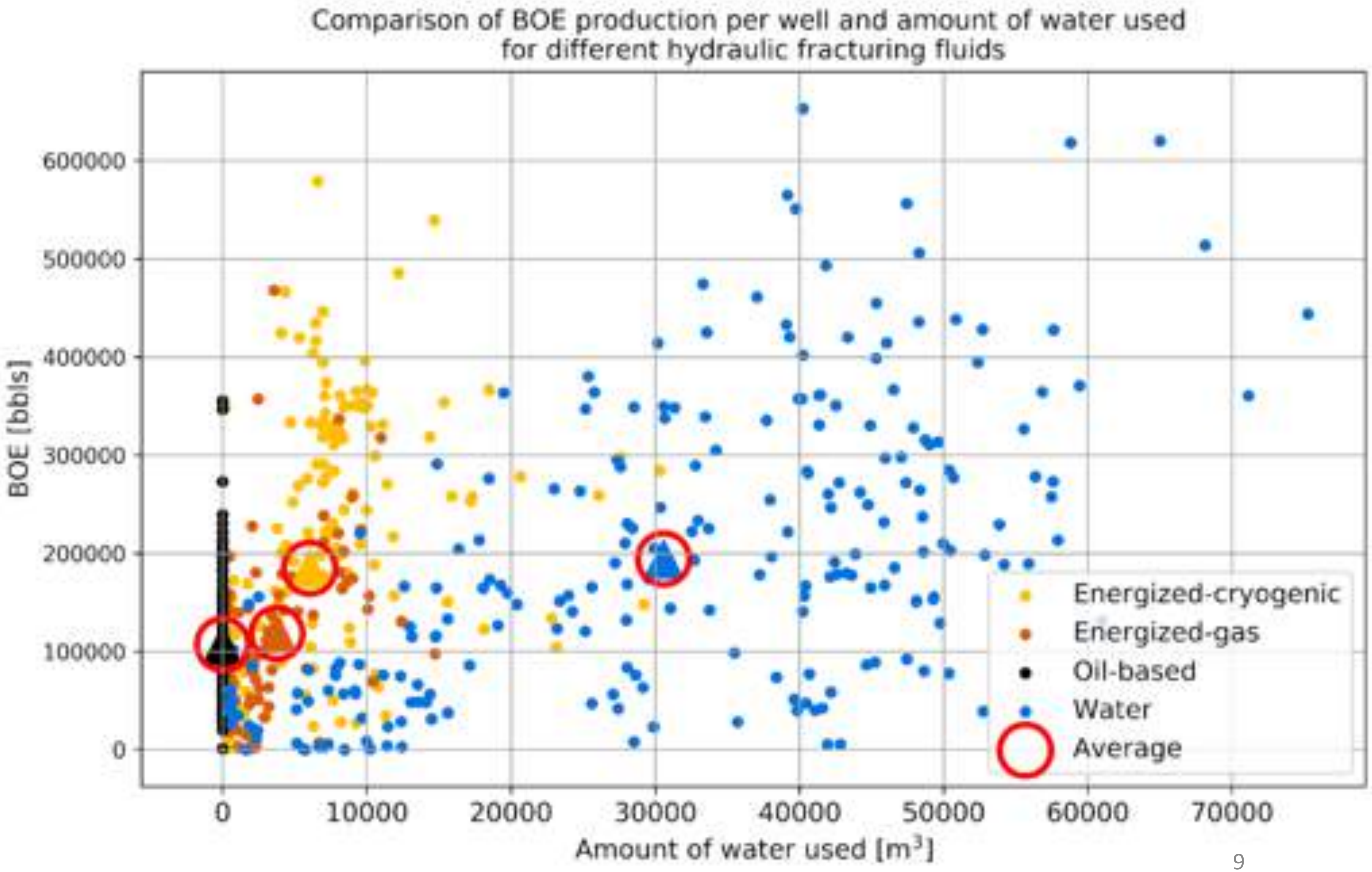
- **598 wells**
- **130 000 km²**
- **Towns, Metis Settlements, Indigenous Reserves**

Methodology

- **Uniform geologic properties** for all wells
- BOE production for **first 12 months**
- A **statistical analysis** carried out to compare **water usage, composition of HFF** (FracFocus) and **BOE** production for each fluid type (geoSCOUT)

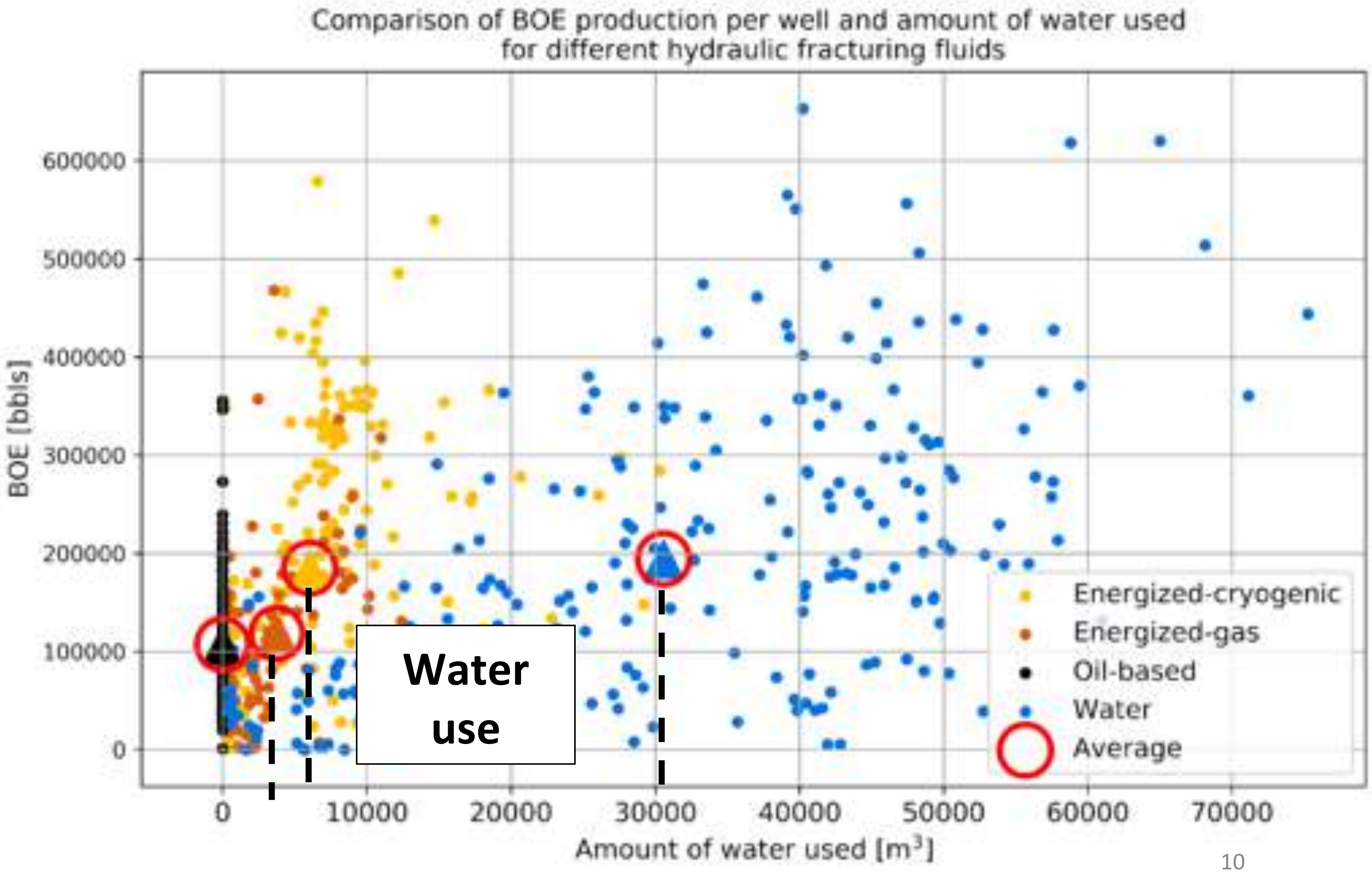
	Water	Energized-cryogenic	Energized-gas	Oil-based
Number of wells	229	178	81	108
Average number of stages	37	26	24	19
Average water used [m3]	30583	6039	3766	0
Average BOE per well	194217	184761	118314	107016
Average efficiency (BOE divided by no. of stages)	5584	7116	5376	5528

Results – BOE/Well vs. Water Usage



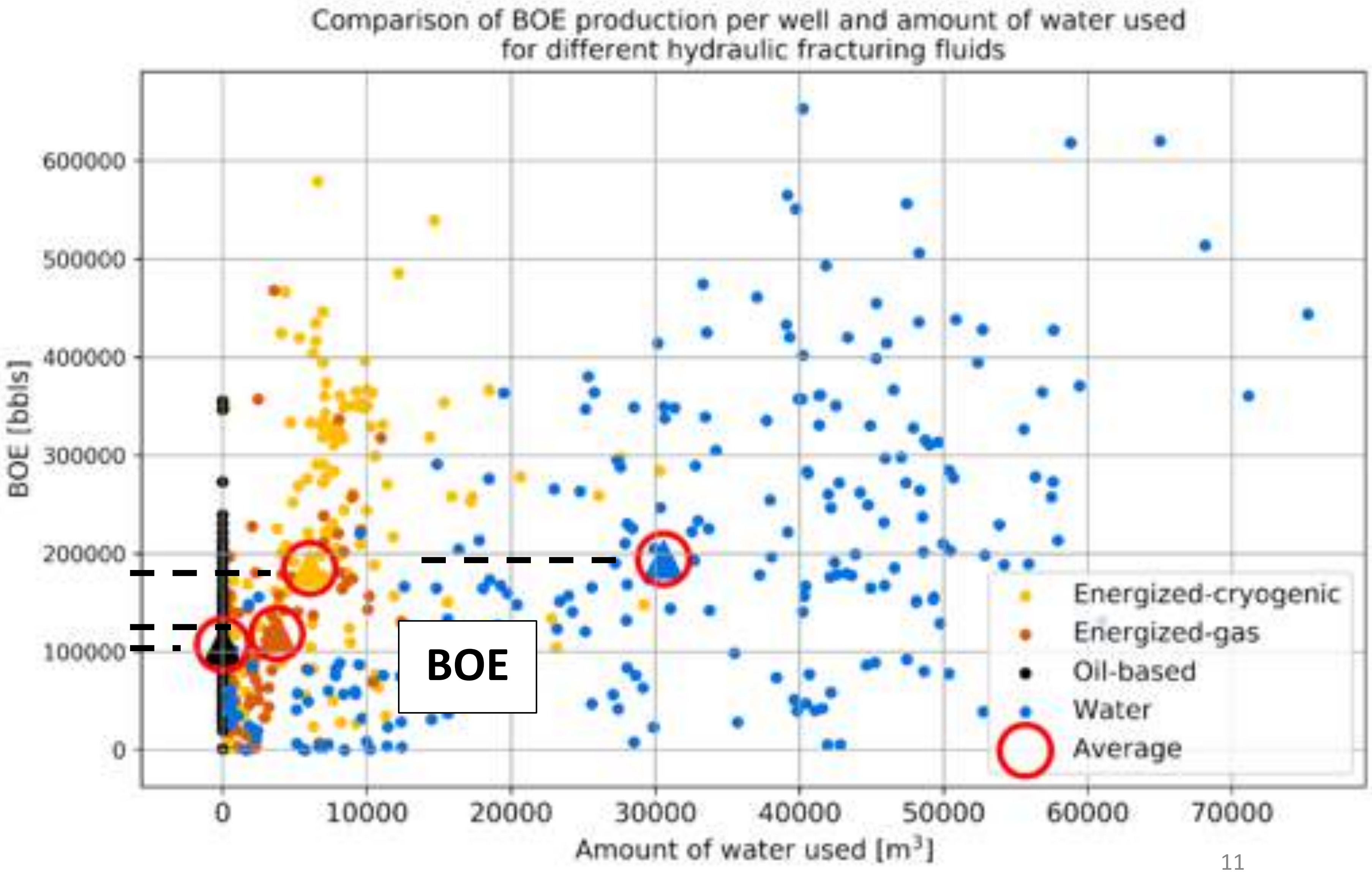
Results – BOE/Well vs. Water Usage

- Water-based wells used much higher water volumes (~80%)



Results – BOE/Well vs. Water Usage

- Water-based wells used much higher water volumes (~80%)
- BOE for Water-based fluids is **slightly higher** than Energized-cryogenic



Results – BOE/Well vs. Water Usage

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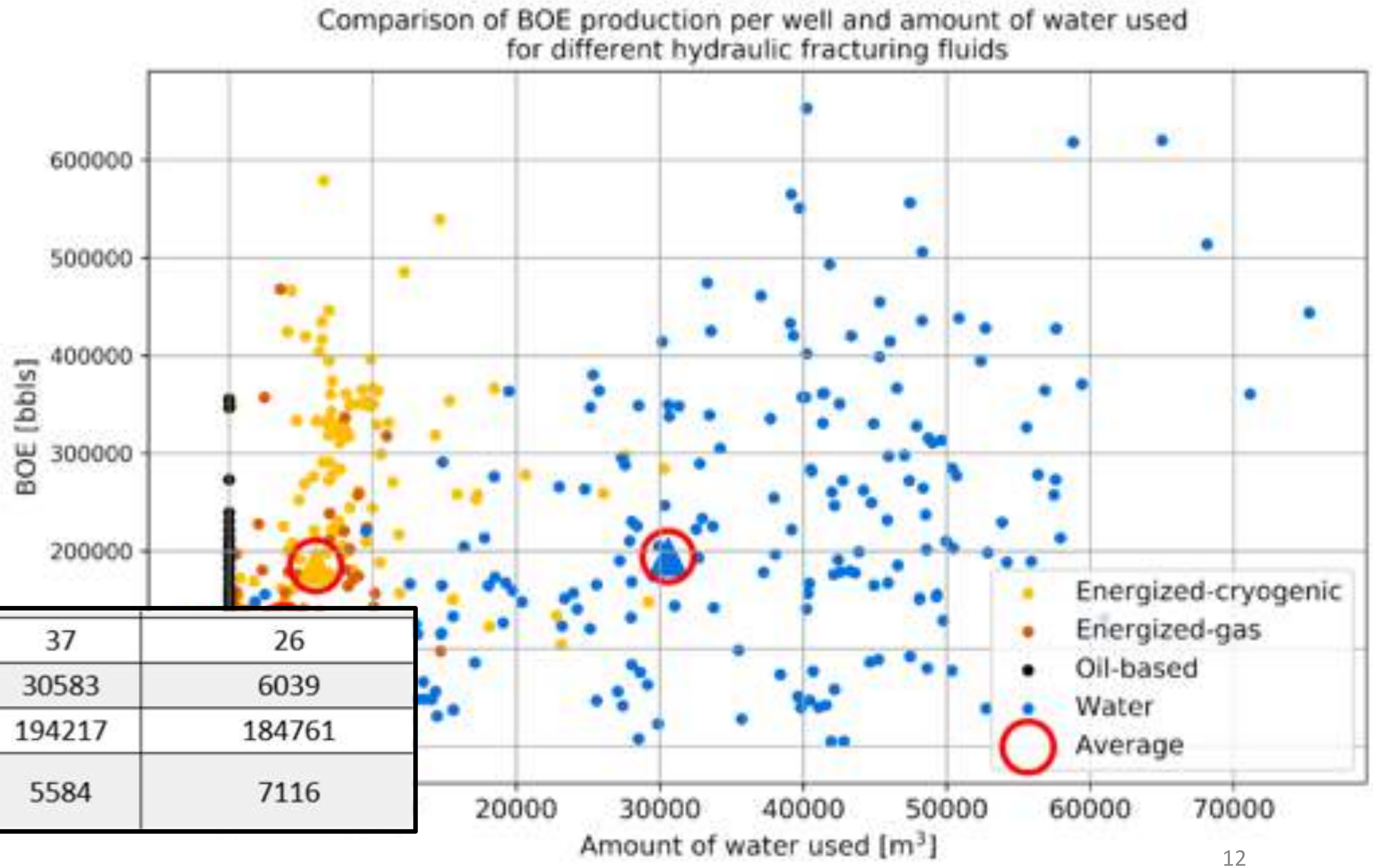
- Water-based 30% more stages, 5% higher BOE



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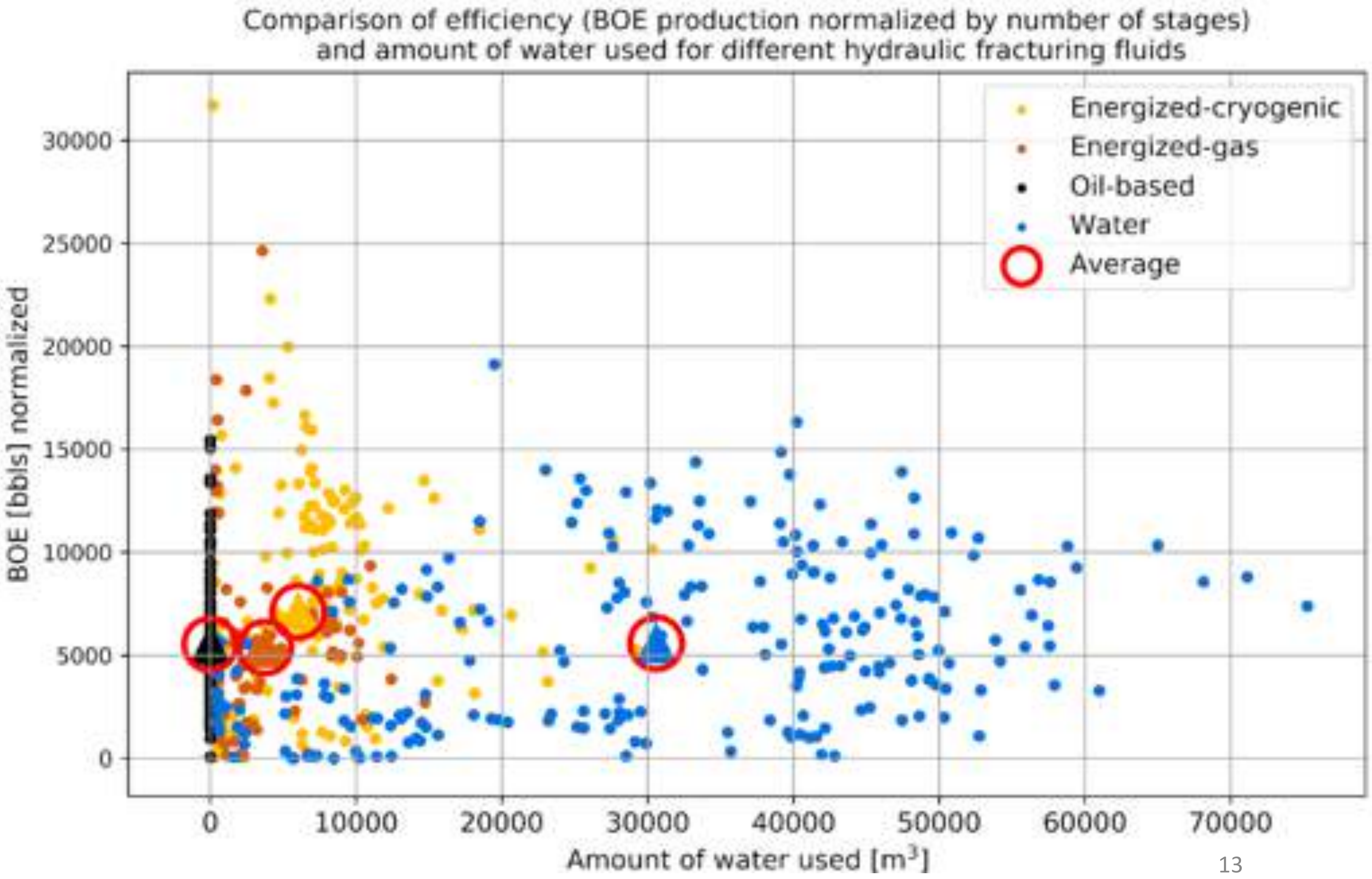
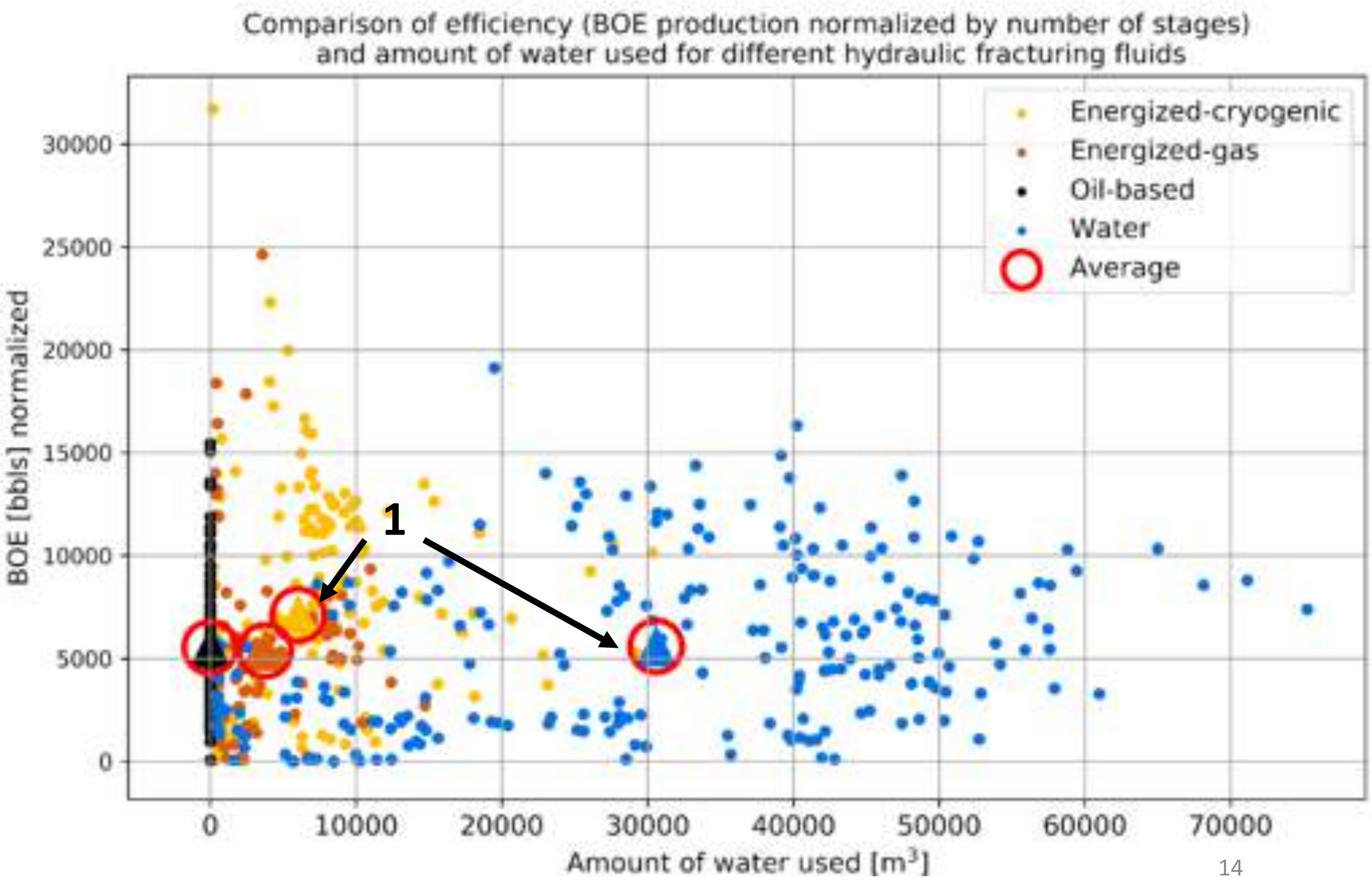
Results – BOE/Stage vs. Water Usage



Results – BOE/Stage vs. Water Usage

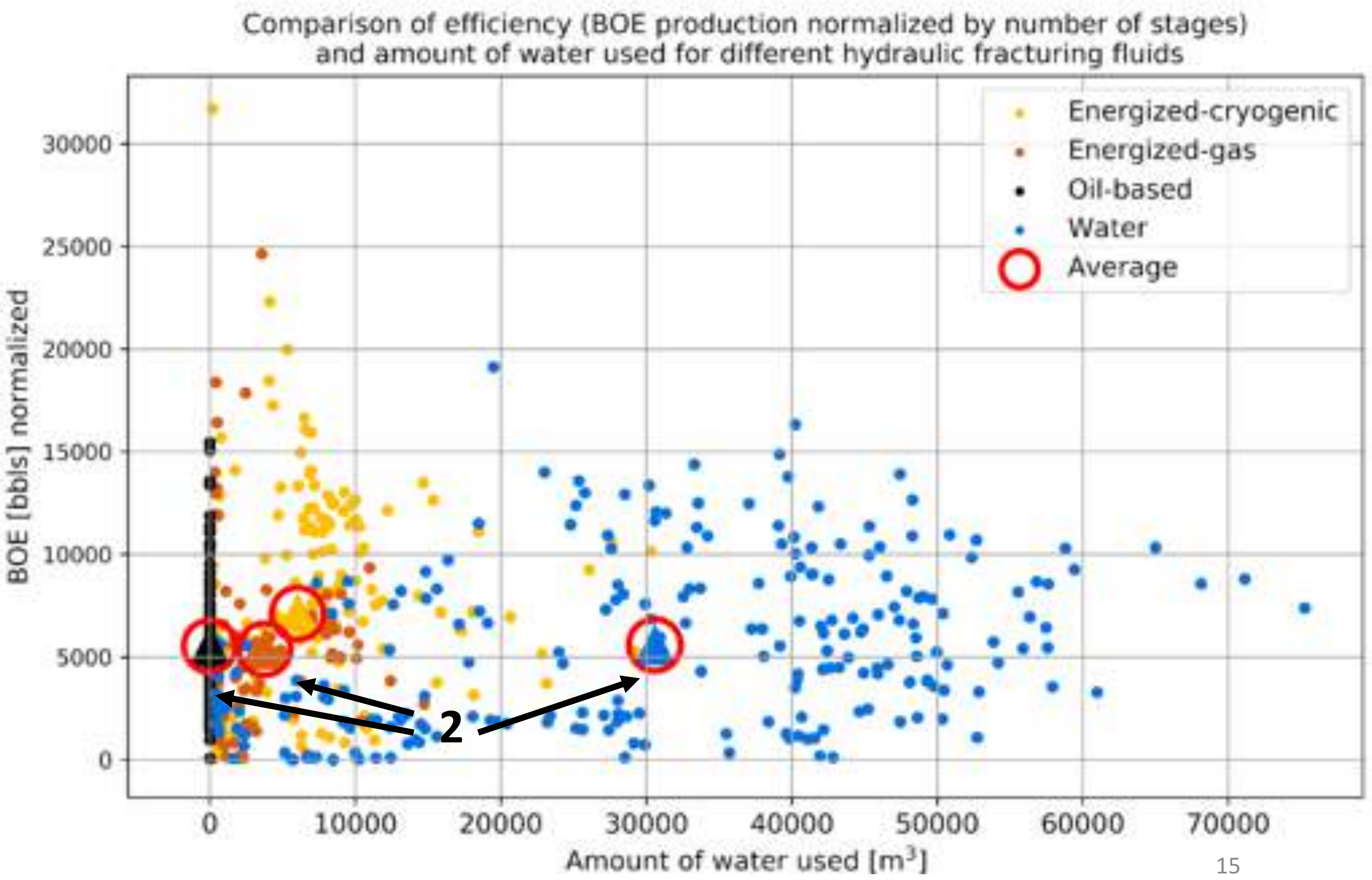
1) Energized-cryogenic vs water-based:
- highest normalized BOE production (**20% more**)



Results – BOE/Stage vs. Water Usage

1) Energized-cryogenic vs water-based:
- highest normalized BOE production (**20% more**)

2) Energized-gas & Oil-based vs Water-based:
- similar efficiency
- lower water use in alternative fluids
  (Oil-based = no water!)



Wells - Statistics

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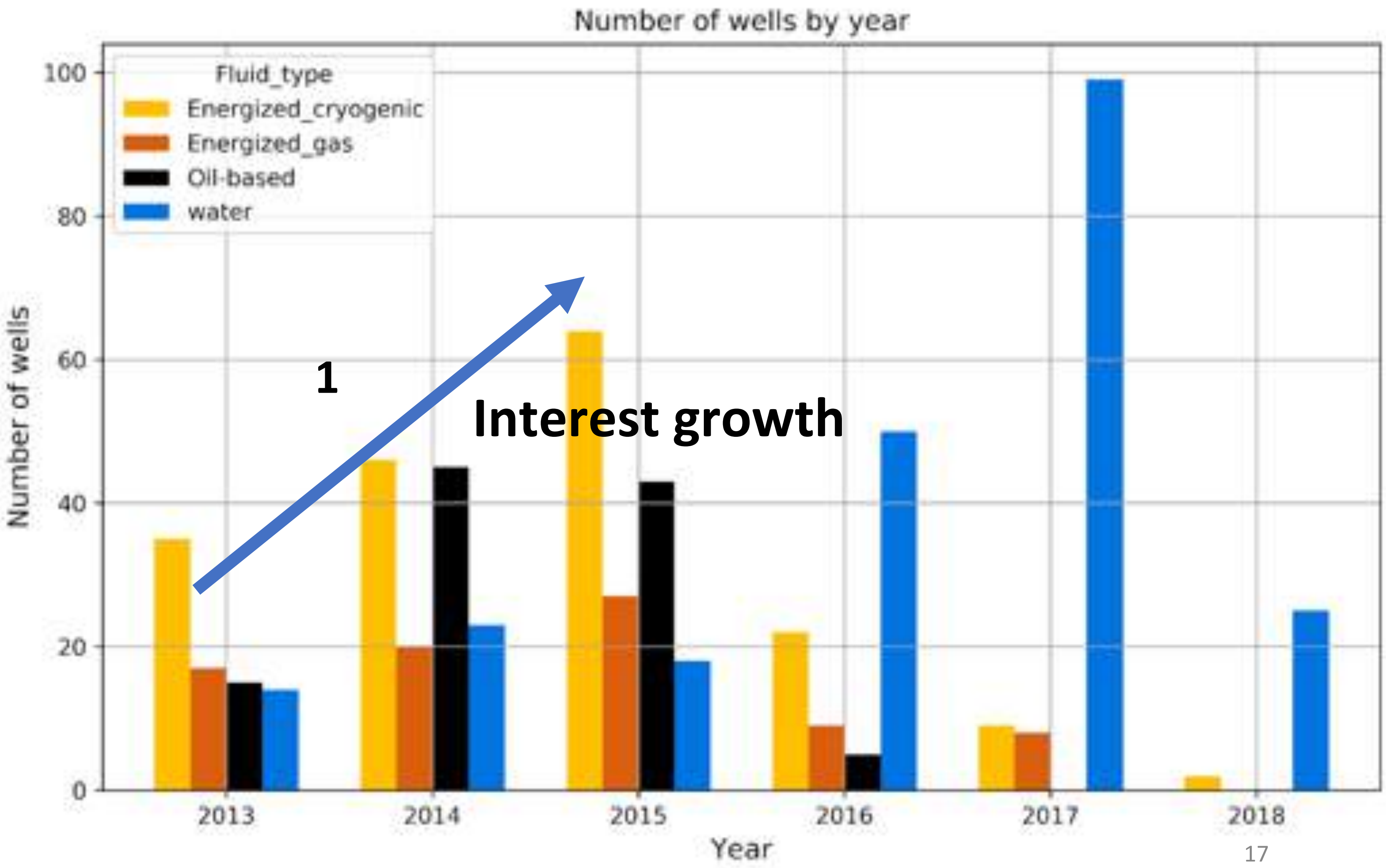
OBSERVATION: Water-based fluids not efficient enough:
~30% more HF stages = more time and $$$
Energized-cryogenic higher efficiency ~20%

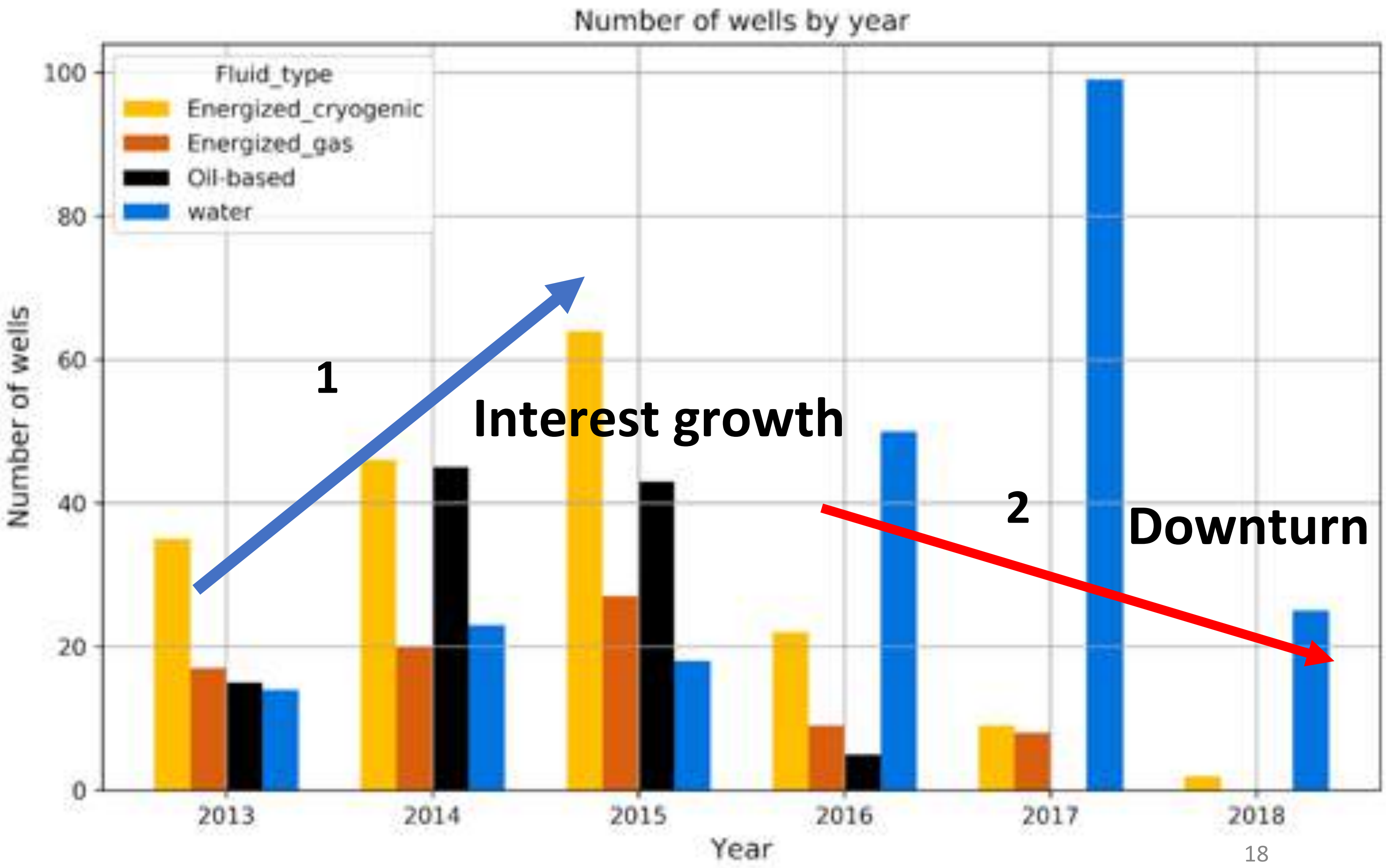
Results – Popularity of Methods

1) Until 2015, alternatives were the most widely used fluid types in HF operations



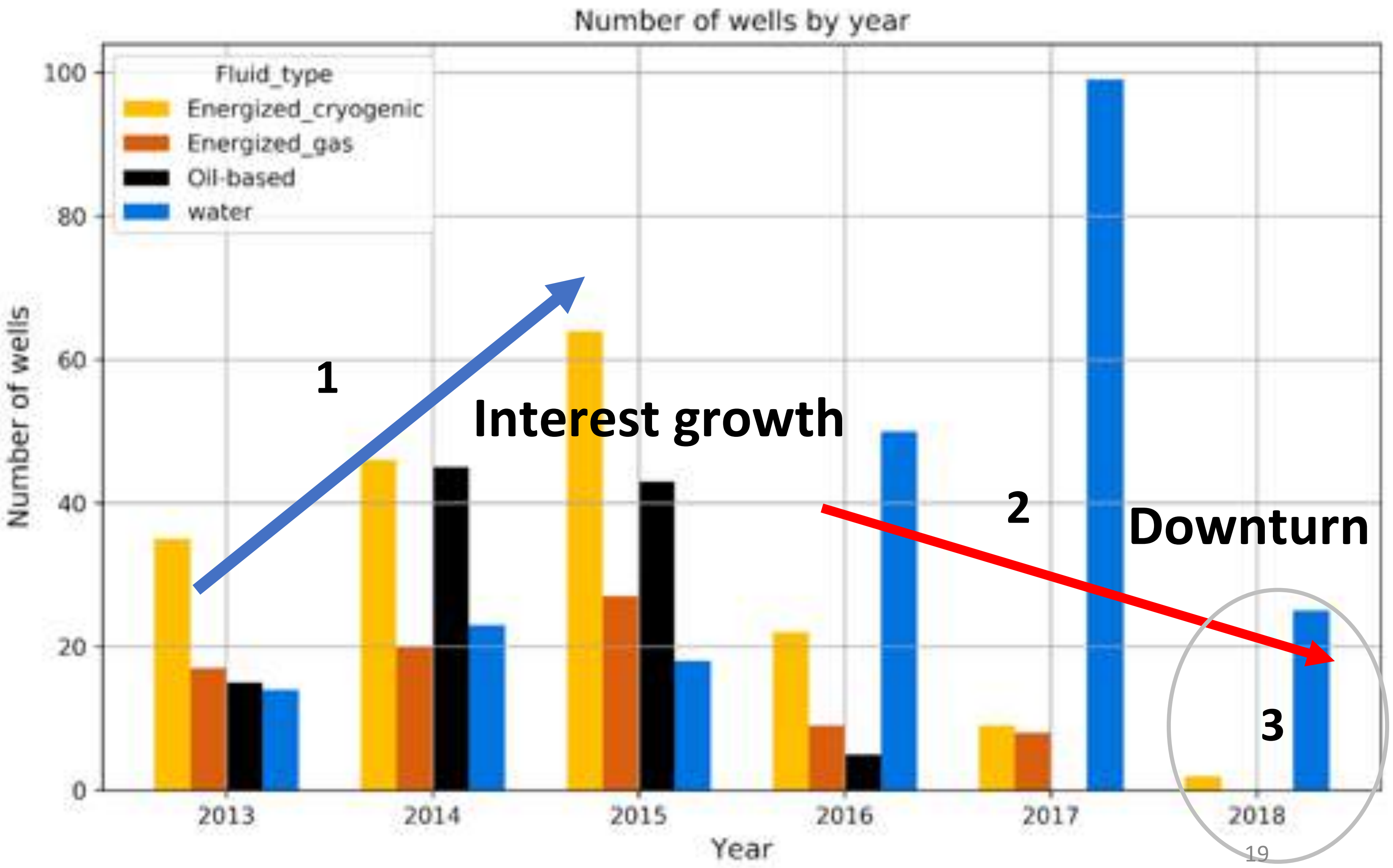
Results – Popularity of Methods

1) Until 2015, alternatives were the most widely used fluid types in HF operations
2) The use of alternate fluids has **decreased** in recent years, likely due to economic conditions



Results – Popularity of Methods

1) Until 2015, alternatives were the most widely used fluid types in HF operations
2) The use of alternate fluids has **decreased** in recent years, likely due to economic conditions
3) In 2018, more than 90% wells used water-based fracking fluids



Numerical modelling

Abaqus FEM (for Kakwa Field):

- Geological

  Depth & thickness of layers
- Petrophysical

  Porosity & permeability
- Geomechanical

  Stress state, pore pressure, & rock mechanical properties
- Rheological properties of injected fracturing fluids

  Viscosity & density

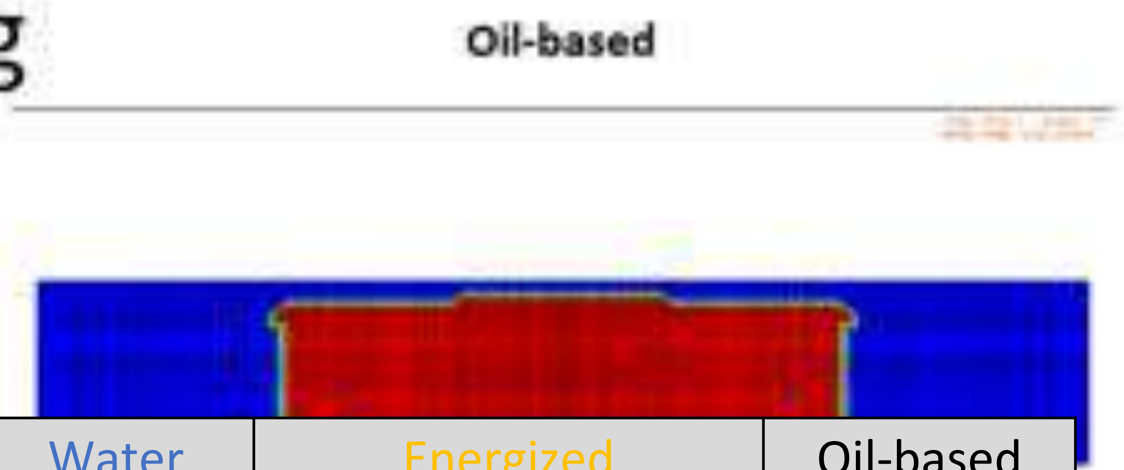
Numerical modelling

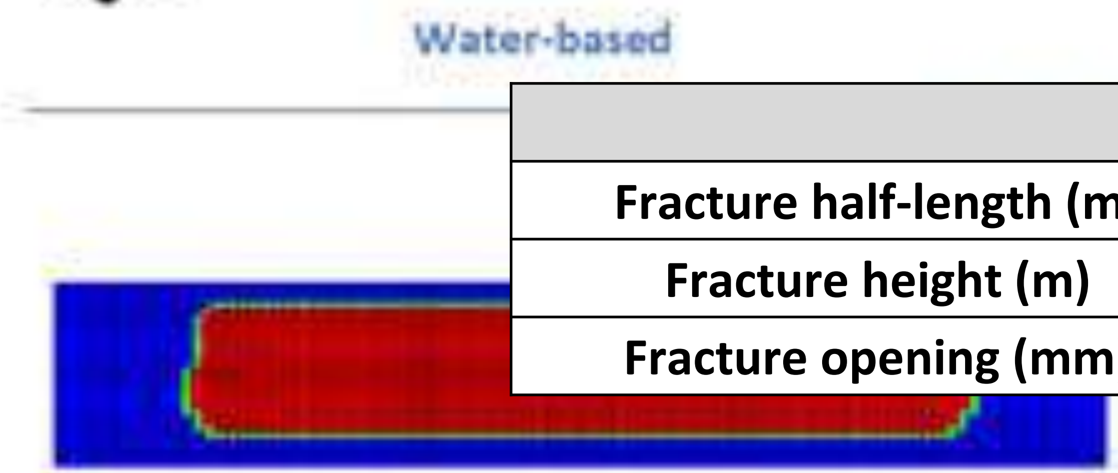
Oil-based

Water-based

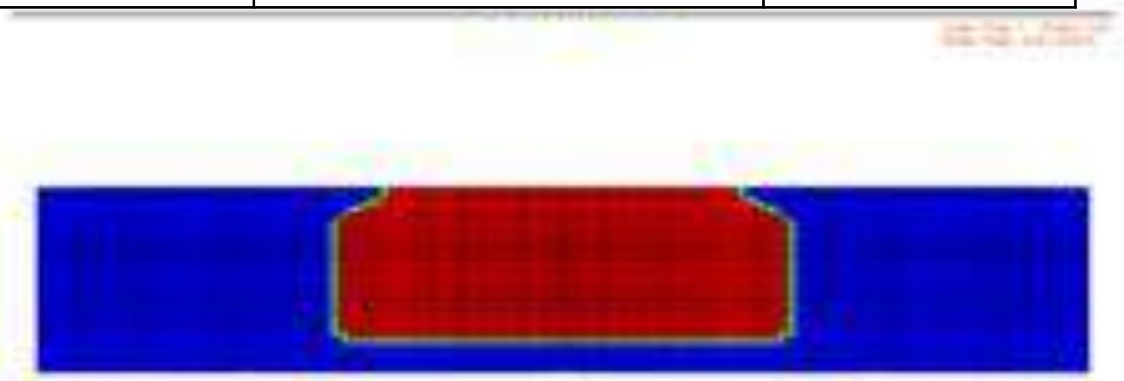
Energized

Numerical modelling





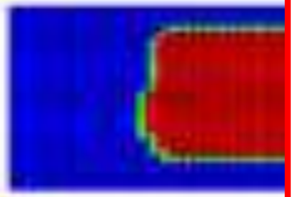
	Water	Energized	Oil-based
Fracture half-length (m)	147	90	109
Fracture height (m)	53	60	63
Fracture opening (mm)	7.6	14	10



Numerical modelling

Oil-based

Water-based



Water-based led to larger fractures, however, based on our analysis on resulted BOE, it is not efficient:

<u>poor proppant transport, clay swelling or water blockage</u>

Unable to use full potential of created fracture!

Analysis Conclusions

- Water-reduced HFF can lead to increased BOE production compared to water-based HFF in the Montney Formation
- Current alternative methods are more expensive that water-based fracking, but higher production rates and reduced production time would encourage industry to start using alternatives
- The use of alternative HFF in the Montney likely depends on the economic conditions of oil and gas prices
- Reduced freshwater consumption would have positive community and natural environmental impacts

Policy recommendation

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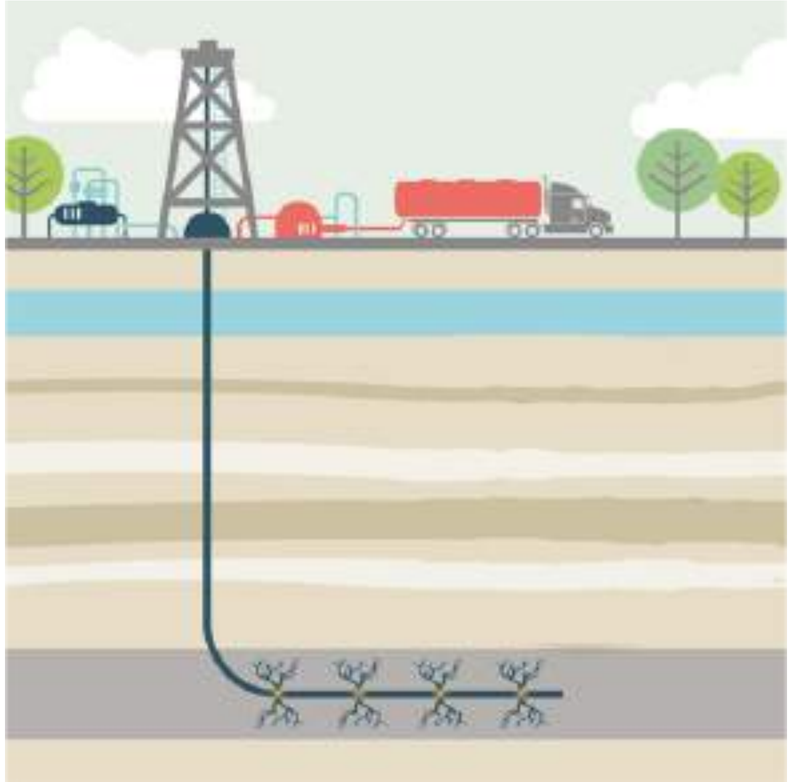

Policy recommendation

- Update the *Water Conservation and Allocation Policy for Oilfield Injection* to include provisions for hydraulic fracturing
  - Provides incentive for easier license renewals if companies achieve the water reduction targets outlined in their license
- Incorporate community and Indigenous voices in the discussions when creating policies
  - including addressing perceived risks and communicating risk management plans,

Questions?

Acknowledgements

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