



# Radio Frequency Heating

Innovating Oil Extraction with Radio Frequency Heating

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June 18, 2019



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# History of Acceleware



**2004** | Acceleware founded

**2007** | Focus on software and seismic products

**2010** | RF studies with US super-major oil company

**2015** | AXE modular RF tank tests & patent filing

**2016** | GE partnership announced  
additional RF XL Patents filed

**2017** | Successful RF XL 1:20 scale field demo

**2018** | Signed commercial-scale pilot agreement with Prosper Petroleum Ltd.

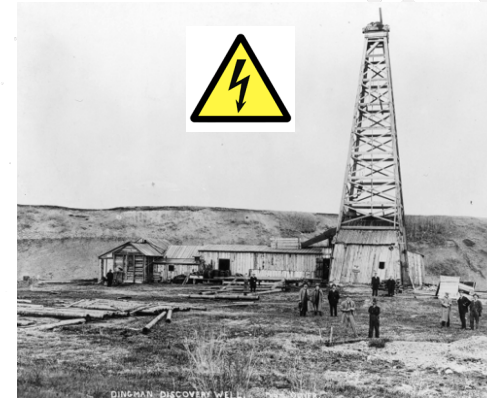
**2019** | Commercial-scale pilot ready

**2020** | Complete commercial-scale pilot deployment of multiple RF XL systems

# RF Heating - History

Use of Electromagnetic Energy

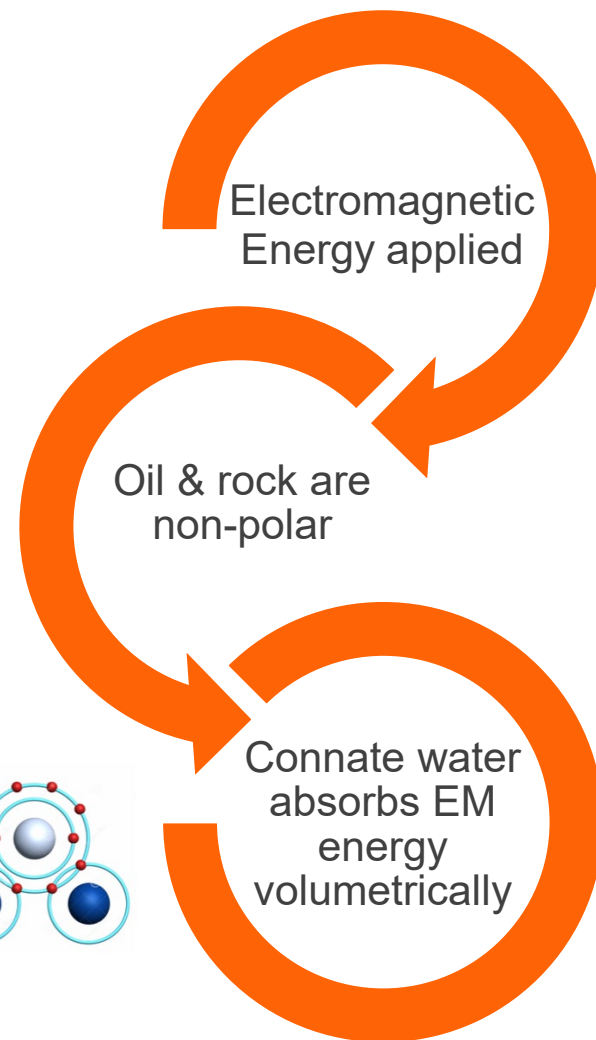
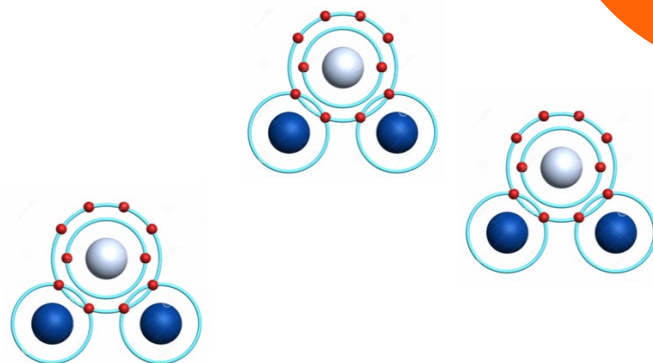
- Has been explored as an EOR method since 1948
- Earliest field tests were in Russia in 1969
- **Limitations have included:**
  - Electrically inefficient
  - High frequency operation
  - High cost of generators, power limitations
  - Short horizontal (<500m) or vertical wellbore designs



Acceleware observed limitations of current EM technologies

# RF Heating - 101

How does it work?



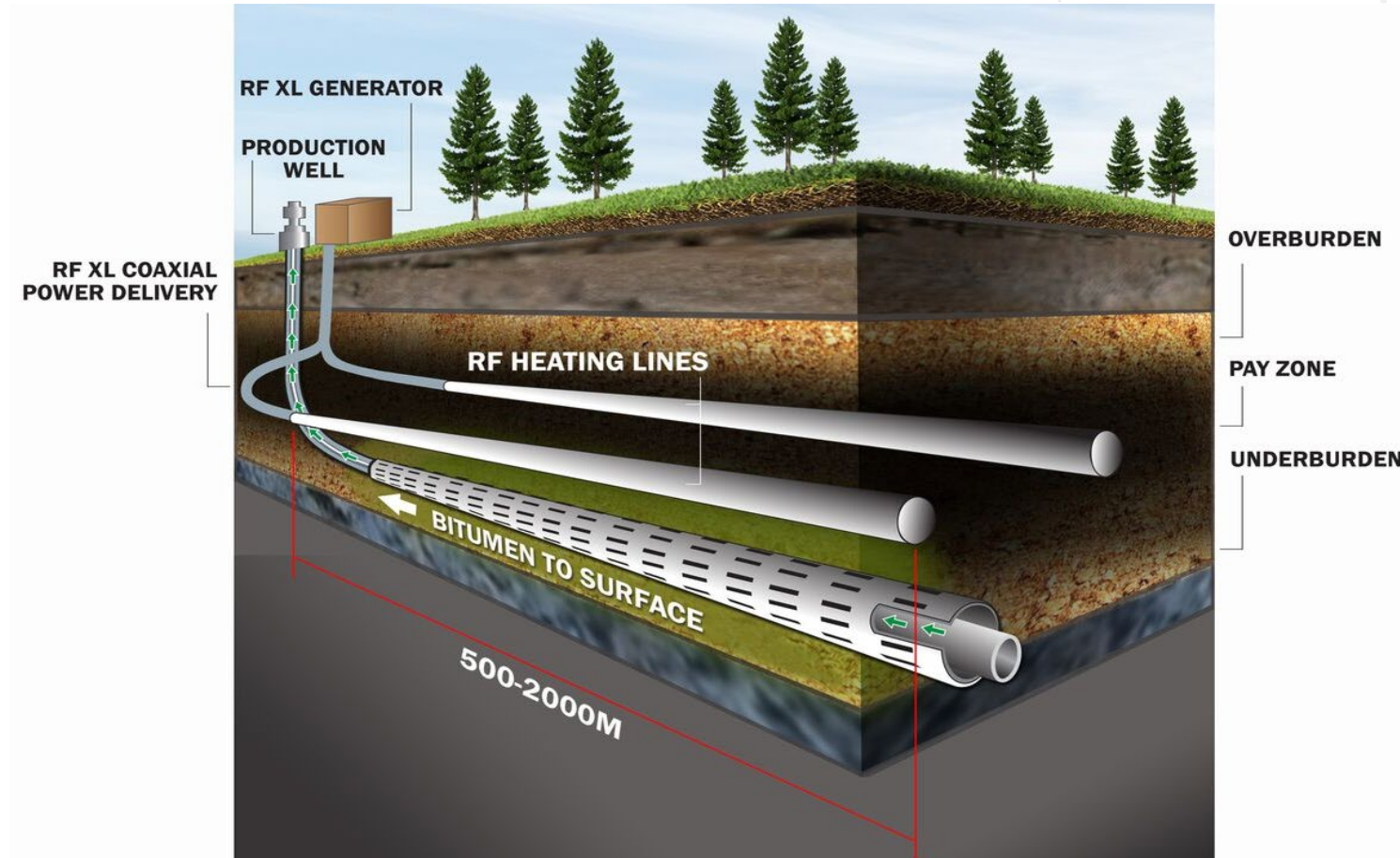
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## In-situ Steam





# RF XL – How it works



RF XL efficient delivery of energy to reservoir

# RF XL - Ideal Reservoir

- Bitumen or Heavy Oil
- Thickness 10-25 m
- Water Saturation 10-35%
- Permeability > 3 Darcie
- Porosity > 25%
- Possible applications in carbonate reservoirs
- Testing ability to desiccate and crack thin shale layers



Photo of McMurray Oilsands

ref: (<http://calindragoie.blogspot.com/2013/11/drilling-and-completion-technologies.html>)

# RF Heating vs. SAGD

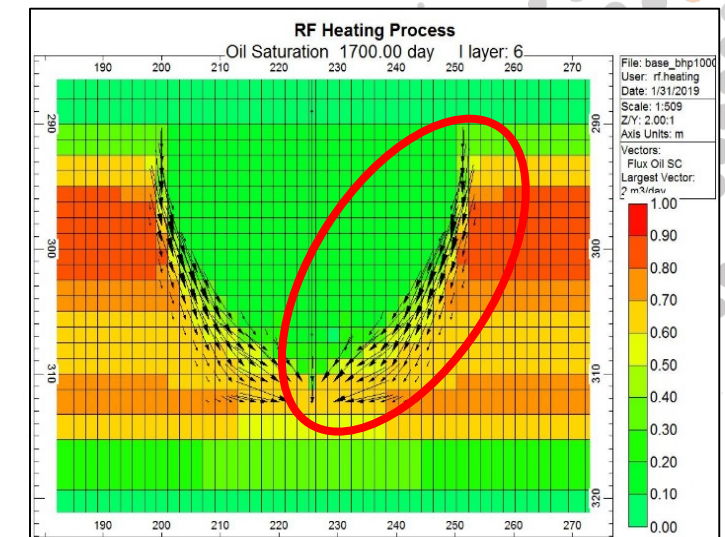
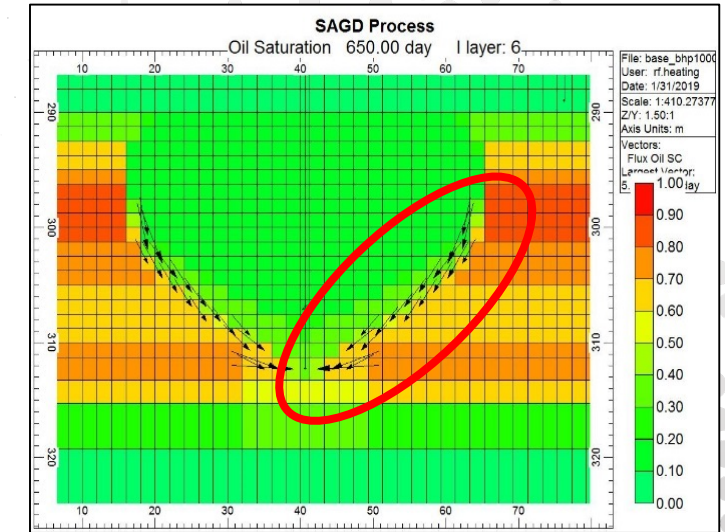
## RF XL Comparison

### Similarities

- 1000m Hz section & well design
- Use of steam & gravity drainage methods

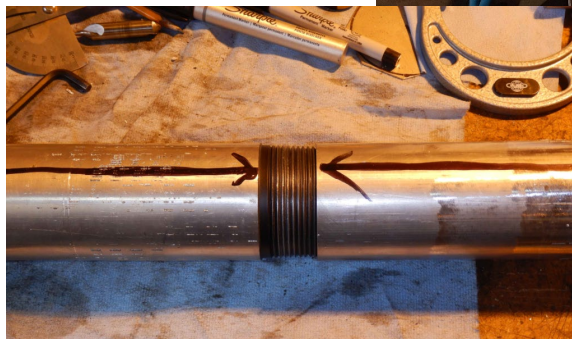
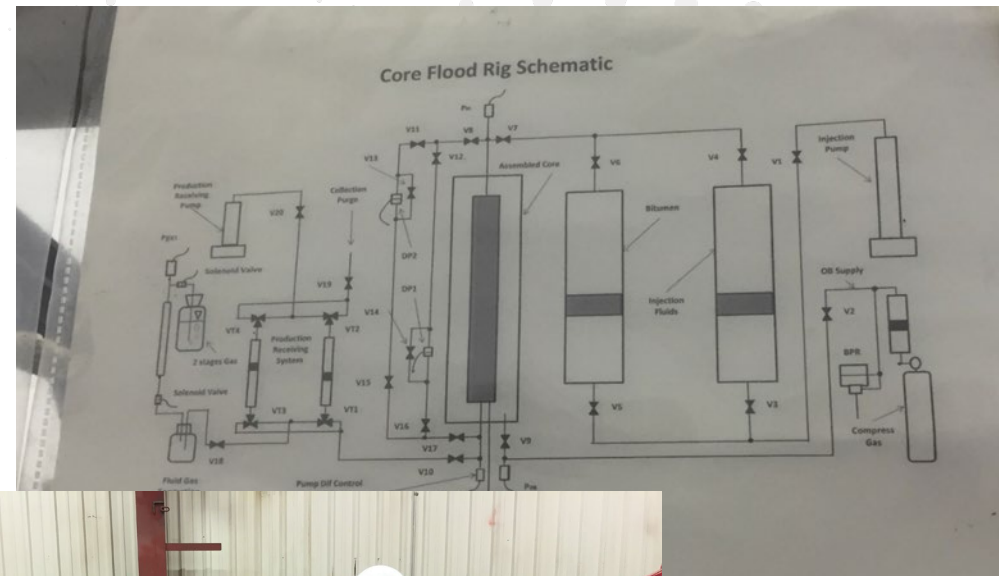
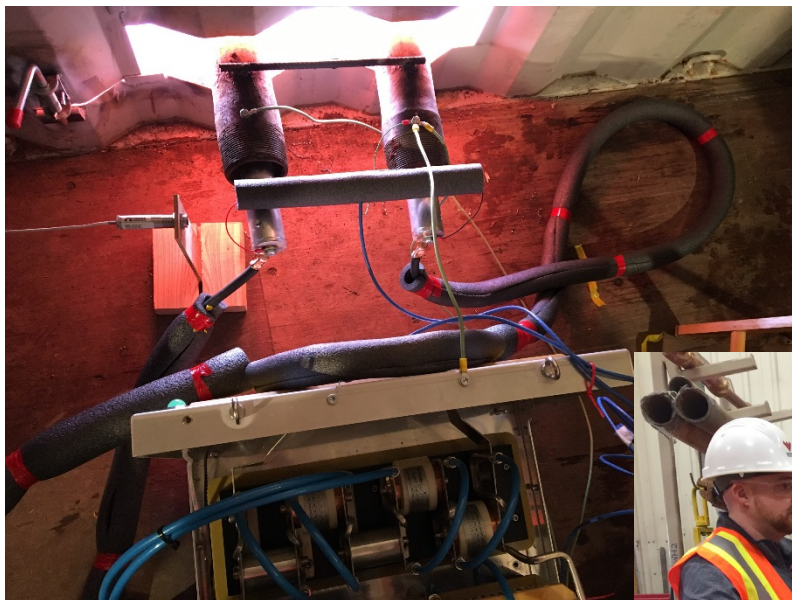
### Differences

- SAGD - heating occurs primarily at interface
- **RF process - heating occurs at interface and beyond**
- Reduced losses & no superheating of steam = lower energy intensity
- $SOR < 2.0$  vs industry average of 2.5-3.5





# RF XL - Testing and De-risking

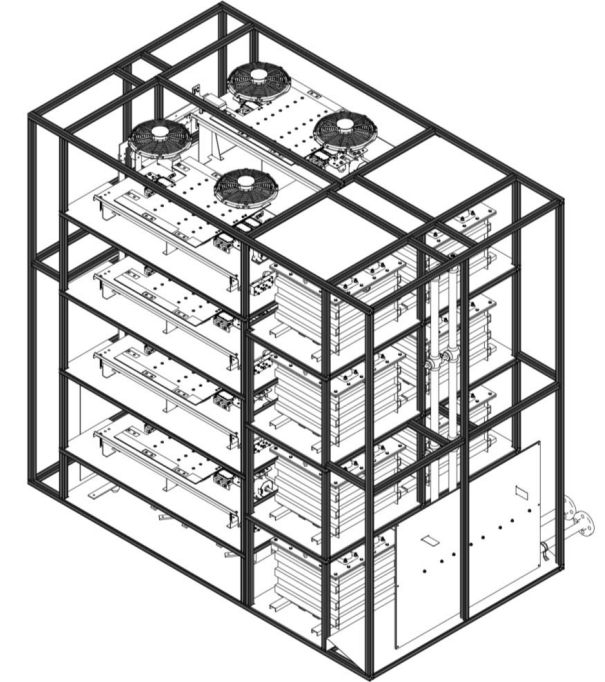
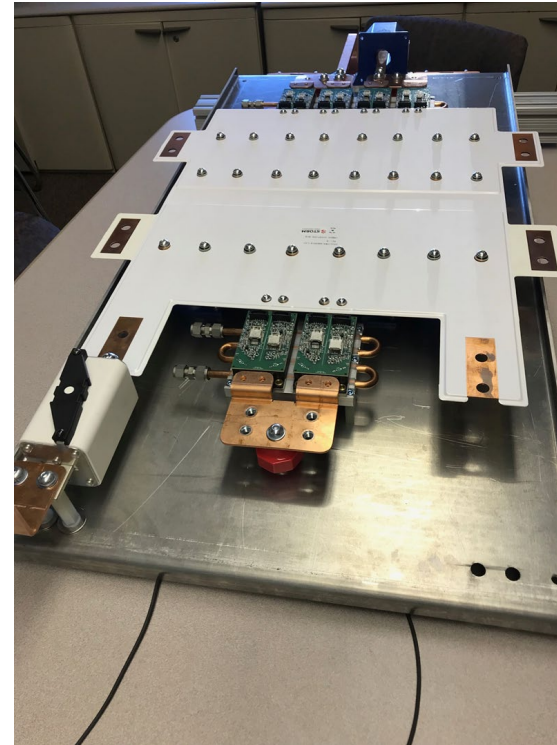
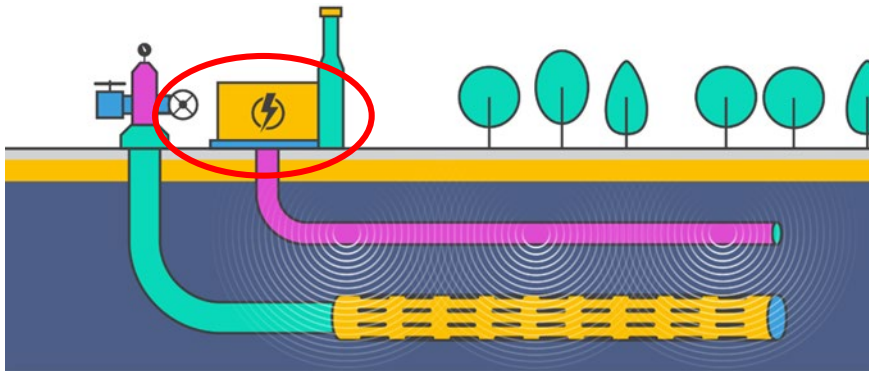


# RF XL - GE Converter Development

High-Power, High-Efficiency, Long-life power platform

## Key advantage to RF XL

- Proprietary design & IP
- GE SiC transistors and power converter platform
- 2 MW maximum power per unit
- Stackable modular design





# RF XL – Benefits vs. Current Recovery

- Lower CAPEX – no steam generation or associated pipeline infrastructure
- Lower OPEX – lower chemical processing requirements
- Lower GHG's (25% - 100%) <sup>1</sup>
- No external water source
- No solvent required

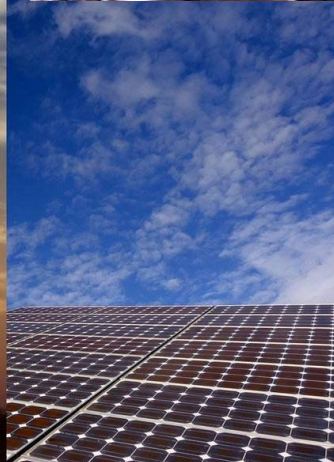






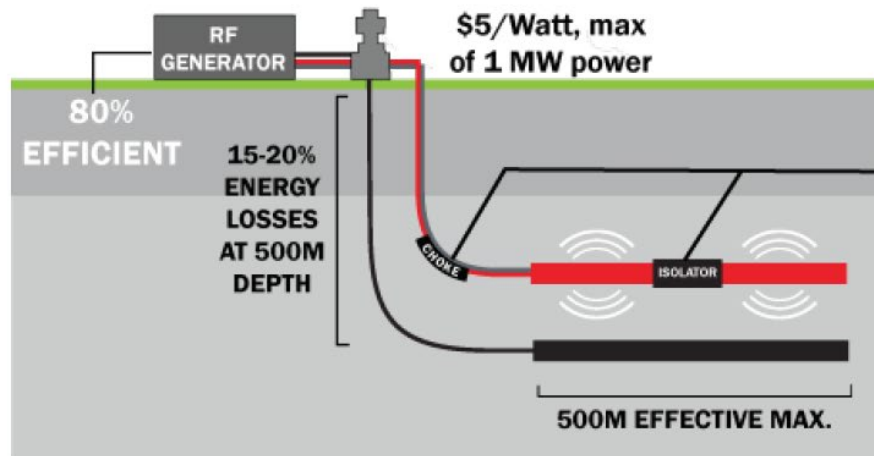
# Next Steps

- Execution of RF XL pilot
- Commercialization of RF XL
- Apply RF to improve bitumen by rail
- Apply photo voltaic solar or other renewable sources in heavy oil application
- Zero GHG heavy oil production



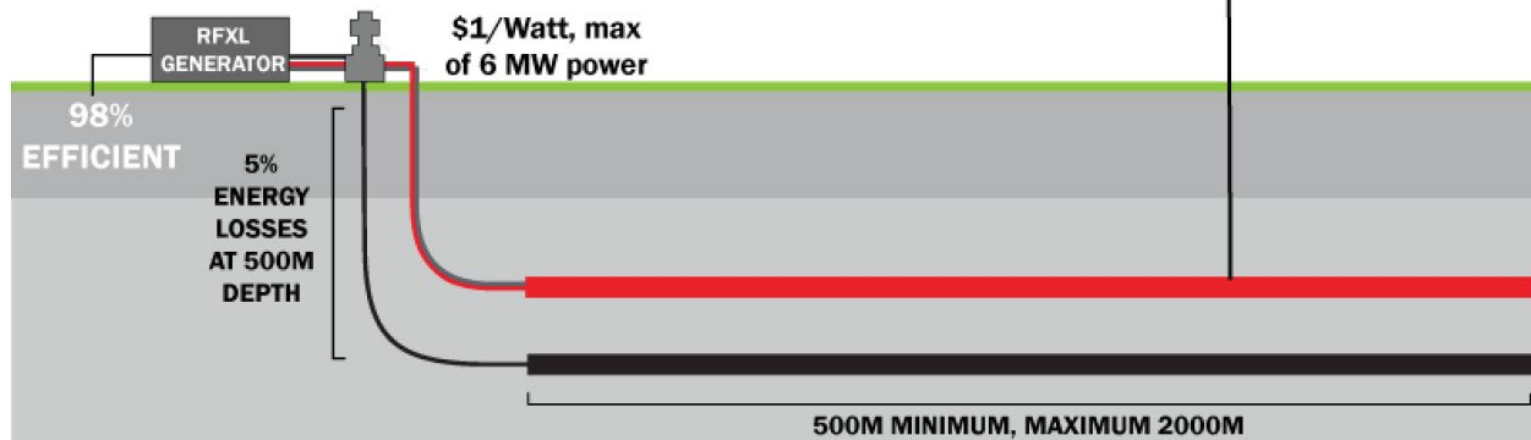
# Antenna Designs

**DIPOLE-BASED RF SYSTEM**



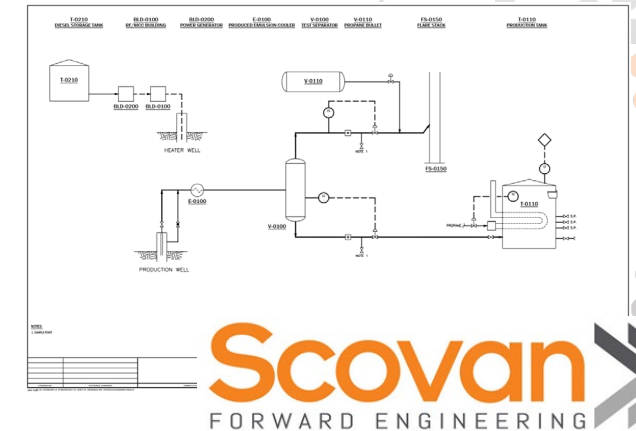
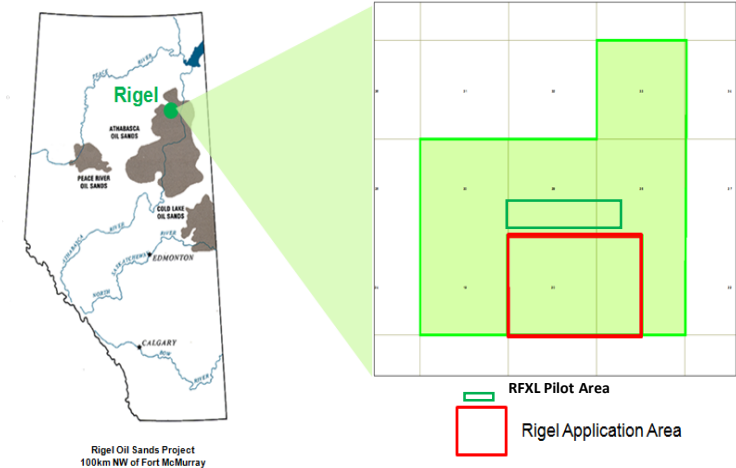
	Dipole Antenna Designs	RF XL Design
Efficiency	80-85%	98%
Well Length	> 500m	500–1000+m
Cost	\$5/m	\$1/m
Power	Max 1 MW	Up to 6 MW

**RF XL SYSTEM**



# RF XL - Project Progress

- Prosper Petroleum agreement signed for test site
- AER application submitted
- GE Global Research RF converter development
- Scovan Engineering Surface Facilities design completed
- Drilling & Completion design in final stages
- Internal simulations and de-risking tests ongoing



GE Global Research

