Plasma Pulse Technology (PPT)
A Reservoir Stimulation Technology for Enhanced Hydrocarbon Recovery
PPT Value Proposition

- Proven technology – Over 300 wells successfully treated globally
- Stimulation of entire reservoir with pulse generated waves
- Enhanced production through increased permeability & reduced viscosity
- Increase in recovery of oil in place
- Clean perforations and aids in reduction of the skin factor
- Minimal capital outlay and increased total ROI
- No damage to the casing or cement around wellbore
- Environmentally friendly (no water or chemicals). No need for EPA permit
- Innovative pay model (fixed fee with bonus incentive/no-fee-revenue sharing)
PPT Technical Summary

Plasma: A powerful instantaneous discharge of super ionized energy propagating a series of pressure pulses

- Plasma Generator creates a series of powerful waves that resonate throughout the reservoir
- Wave propagation improves hydrocarbon recovery through increased permeability
- Treatments tailored to geologic composition
- Does not affect the integrity of the wellbore
The treatment duration and number of pulses stimulating the formation are determined by the OIP, production interval parameters and geological characteristics of the deposit.
Plasma Pulse Generation


- Calibrated metallic conductor is ionized via a powerful electric charge that generates a high intensity Plasma Pulse

- This process generates a significant amount of energy in a short time

- Energy from the Plasma pulses creates a series of nonlinear elastic shock waves that propagate into the reservoir

- Broad spectrum wave propagation cleans perforations and creates micro-fractures, leading to increased production rates
Unsupported cement is not debonded off test target during plasma pulsing.

The perforations become unplugged and open to allow fluid entry post pulsing.

Simulated blocked perforated casing target before pulsing

Target post pulsing
Operational Procedure

- Geologic / field evaluation and well selection
- Operator provides well data including but not limited to historical production, neutron/gamma ray log, CBL, fluid level, perforation interval, PLT, BHT, BHP, etc.
- Treatment plan determined & agreed upon
- Schedule treatment in coordination with scheduled maintenance
- Operator prepares well for treatment
- Arrival on site with wireline, wireline crew, Novas Energy tools and crew
- Administer treatment per plan
- Perform post-treatment evaluation including production data sharing (oil, gas, condensate, water)
- Implement ongoing field treatment plan
Case Studies
# Results from Oil Producing Wells

<table>
<thead>
<tr>
<th>Oil Field</th>
<th>Depth (ft)</th>
<th>Oil Bpd</th>
<th>% Watercut</th>
<th>Oil Bpd</th>
<th>% Watercut</th>
<th>Oil, Bpd Increase</th>
<th>% Increase</th>
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## Injection Well Results

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<tr>
<th>Oil Field</th>
<th>Bbls/Day Before</th>
<th>Bbls/Day After</th>
<th>Increase</th>
<th>% Increase</th>
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Increase in the Well Production Rate

Well #: C-7
Oil field: Russia, Dyusushevskoye
LLC Polar Lights Company
Reservoir: Carbonate
Well Type: Production Well

DFL = Dynamic Fluid Level, PI = Productivity Index

- DFL before treatment – 2250
- DFL after treatment – 1817
- Formation – D3fm
- Operating capacity – 8,6 m
- PI before treatment – 0,09
- PI after treatment – 0,33

DFL = Dynamic Fluid Level, PI = Productivity Index
Increase in the Well Production Rate

Well #: 70
Oil field: Russia, Zapadno-Sikhoreyskoe
LLC Polar Lights Company
Reservoir: Carbonate
Well Type: Production Well

DFL before treatment – 2245
DFL after treatment – 1373
Formation – D3fm
Operating capacity – 16,2 m
PI before treatment – 0,55
PI after treatment – 1,84

DFL = Dynamic Fluid Level, PI = Productivity Index

Pre Treatment | Post Treatment | March | April | May | August | September
536 | 126 | 1040 | 290 | 1096 | 309 | 1071 | 353 | 1049 | 350 | 990 | 282 | 993 | 280

Oil BOPD | Water BLPD
Increase in the Well Production Rate

Well № XXX8 Vatyaganskoe Field
Increased Productivity After Plasma Pulse Treatment
(IN HYDRO-FRACKED FORMATION)

Well #: 753
Oil field: Vatyoganskoye
Reservoir: Tight Sand
Object: Enhance Oil Recovery
Permeability: 3 mD
Increased Productivity After Plasma Pulse Treatment (IN HYDRO-FRACTED FORMATION)

Well #: 9208
Oil field: Vatyoganskoye
Reservoir: Tight Sand
Object: Enhance Oil Recovery
Permeability: 17 mD
Increased Productivity After Plasma Pulse Treatment
(IN HYDRO-FRACKED FORMATION)

Well #: 9138
Oil field: Vatyoganskoye
Reservoir: Tight Sand
Object: Enhance Oil Recovery
Permeability: 10 mD

Dynamic Fluid Level (ft)

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<th></th>
<th>March</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
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Oil BOPD | Water BLPD

Pre Treatment: 480 | 85
Post Treatment: 713 | 110
June: 660 | 50
July: 698 | 125
August: 885 | 158
September: 930 | 113
## Average Daily Oil Production
### Taylakovskoe Oil Field

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</tr>
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</table>
Decline Curve Before and After PPT

Downward production trend before PPT and after PPT
Terrigenous deposit, Taylakovskoe oil field, Megionneftegas

bbl/d

Novas Energy North America, LLC • 2015

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