PROJECT SUMMARY AND OUTCOMES

GRID POWERED SITE CONVERSIONS

NAL, now owned by Whitecap Resources Inc., has devised a repeatable and cost-effective solution for pneumatic to electric chemical pump conversions in grid-powered fields that can significantly reduce the need for other 'SMART' pump technologies in the market.

Prepared by NAL as part of the Methane Consortia Program

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Project Summary

NAL, now owned by Whitecap Resources Inc., has developed a repeatable and cost-effective solution for pneumatic to electric chemical pump conversions in grid-powered fields that can significantly reduce the need for 'SMART' pump technologies currently offered in the market. NAL has applied the learnings from its Q4, 2018 pilot of SMART pumps on four sites in Olds to devise a cheaper, more effective solution that utilizes existing infrastructure, including grid support to materially reduce full cycle costs of chemical pump retrofits by upwards of 75%.

This project-type has the potential to reduce the minimum economic threshold of emissions necessary for candidate selection from >85 tCO2e/YR/site using SMART pump technologies to <50 tCO2e/YR/site in assets across the Alberta Basin.

Technology Summary

For grid-powered sites, NAL has chosen to replace existing TexSteam pneumatic (fuel gas) chemical pumps (or equivalent pump models) with electric driven pumps using existing inventoried or readily purchasable components. In so doing, previously consumed (and vented) fuel gas is conserved thereby reducing site emissions.

Since generating carbon credits was not applicable in the Methane Consortia Program (MCP), NAL selected 14 sites at or below the economic threshold of emissions mitigation not usually considered for carbon crediting programs as an avenue to further its technical understanding in such conversions. Concurrent with MCP, NAL also effected operations at an additional 7 identified sites that exceed 85 tCO2e/YR/site which are more conducive to mainstream carbon credit generation programs using the same conversion practices.

NAL instituted an excel-based record keeping process to properly incorporate and disseminate necessary data collection including daily injection pressures and injection rates as an avenue to credit generation success on applicable assets. Such displays would normally be sent to the Aggregator (i.e., Bluesource or Radicle) for proper and effective administration of carbon credit generation programs, however for the MCP project, they are mostly for anecdotal purposes. NAL may trial a more interactive record keeping process under the preferred telemetry, power, and operating conditions but for the time being, this simple process fulfills aggregator needs on those pumps intended to attract credits. Learnings have allowed some elimination of the use of smart technologies coupled with the creation of a real-time record keeping system which mimics the SMART pump data acquisition. As a further learning, since automated data collection was not required, this reduced equipment costs significantly.

This approach to eliminating venting from chemical pumps works well with grid power available. Furthermore, the retrofit plan provides an alternative to SMART pump technologies for larger operations with strenuous record keeping and available grid power.

Purchase and Installation Process

The TexSteam chemical pump is a workhorse in the oil and gas industry, having been used for fluids injection in the Alberta Basin for decades. In particular, the Series 5100 product line is pervasive and primarily used for methanol injection which accounts for a significant portion of overall venting from chemical pumps.

NAL completed a field-derived inventory of its entire chemical pump asset base (~1500 items) in Summer 2019 by acquiring a predetermined set of static and dynamic operating parameters gained from conversations with the Aggregator and confirmed with AER Manual 15 required inputs. After completing Manual 15 calculations, the data base was sorted both by emissions per pneumatic pump, then aggregated as emissions per site (tCO2e/yr/site) and later, using a proprietary economic model, an economic threshold in tCO2e/YR/site was derived for consideration of most appropriate funding and suitable locations.

Available funding options included self funding, 3rd party funding, and Funders such as PTAC (i.e., MCP, STV), ERA, SDTC, NRCAN, AEP, etc. NAL preferred the PTAC/EEA/MCP funding option for this suite of recommended sites given the level of emissions per site being effectively on the threshold of economic viability to more traditional carbon credit generation programs. Preferred funding was selected using average input parameters of emission volume in scf/d, decline percentage, carbon value, capital and strip price and a variety of funding structures in the economic model gained from knowledge of prior agreements with the Aggregator or stipulations in funder campaigns.

After further review of the prospective company-wide site rankings situated over the calculated economic threshold, a decision was made to focus on NAL's Olds Area exclusively for this pilot given maturity of the field, its mostly 24/7/365 chemical pump operation, and excellent collaboration with the electrical and instrumentation (E&I) preferred vendor, lead instrumentation technician and field operations. A broad list of sites was provided to the field and after a few passes of the inventory to screen for outlier sites due to cost and complexity or other logistics challenges, 14 sites were selected for the trial (see Table 1 below). All field work for this project was carried-out between September 2020 and December 2020, timed with affording some reasonable period of review ahead of reporting and Program expiry (June 2021).

Bottomhole LSD	Number of heads Installed	New Install or Retrofit	Average Emissions (t/CO2e/yr/site)
100/07-02-030-01W5/00 (vt)	Triplex (3)	New Install	66
100/02-01-033-02W5/02 (surf 14-01)	Duplex (2)	New Install	64
100/02-02-031-02W5/00 (vt)	Simplex	New Install	53
100/11-16-029-28W4/00 (vt)	Duplex (2)	New Install	60
100/10-05-032-01W5/00 (vt)	Duplex (2)	New Install	59
100/03-05-029-28W4/02 (surf 10-05)	Duplex (2)	New Install	58
100/10-12-030-01W5/00 (vt)	Duplex (2)	New Install	71
100/08-27-030-29W4/00 (surf 15-27)	Duplex (2)	New Install	27
100/16-02-031-01W5/00 (surf 5-11)	Duplex (2)	New Install	71
100/04-02-031-01W5/03 (surf 9-03)	Duplex (2)	New Install	54

100/13-24-031-01W5/00 (surf 2-24)	Duplex (2)	Pump Head added to Existing Electric Pump removing a pneumatic pump. Purchased new pump heads.	35
100/08-01-031-01W5/00 (vt)	Duplex (2)	Pump Head added to Existing Electric Pump removing a pneumatic pump. Purchased new pump heads.	26
100/06-07-033-01W5/00 (surf 8-18)	Duplex (2)	New Install	69
100/16-11-032-01W5/00 (vt)	Duplex (2)	New Install	104

Table 1: MCP Program selected well sites (2020)

Project Schedule

Activity	**Start Date**	**End Date**
Desktop & Field Study (same as above)	4-01-20	6-30-20
Establish Necessary Design Parameters	7-01-20	7-31-20
Consultation with Vendors/E&I	8-01-20	8-31-20
Hi-Grade Candidates	9-01-20	10-31-20
Field Work	11-1-20	12-31-20

Table 2: Project schedule

Emission Profile

Summary of GHG mitigated due to the project

Using Manual 15 calculations, based on the 14 installs that were part of this project, NAL estimates a total GHG mitigated volume due to this MCP project alone of ~817 tonnes of CO2e/YR for an average of approximately ~58 tCO2e/YR eliminated per installation.

While each of the 14 sites exhibited a variety of operating parameters, if one were to normalize to average chemical pump inputs of 15 l/d (full year), 1378 kPa pumping pressure (200 psi), 3/8 plunger and 1" stroke length, the resulting annual emission is approximately 68 tCO2e for a single pump. Therefore, the batch of 14 sites chosen in the MCP Program is a good cross-section of the industry fleet of chemical pumps.

At the time of application, NAL had assumed a project sample size of 5-10 sites to fit within the scope of funding NAL was willing to match (according to the MCP directives), however NAL was able to conduct operations at 14 sites under the committed funding which broadened the site variables for execution and subsequently decreased the average site abatement from an assumed 80 tCO2e/YR in the application to ~58 tCO2e/YR in the final synopsis.

Abatement Cost

The abatement cost as per the original application over a 10-year period was estimated at approximately \$6.25/tonne of CO_2e mitigated. This abatement was based on an average cost of \$5,000.00 per site and an average emission mitigation of 80 tCO_2e/YR. After completing the project for the 14 sites that realized a retrofit, the abatement cost over a 10-year period was calculated to be \$8.56/tonne of CO_2e mitigated. The average cost per retrofit is still consistent with the original application, however the average emission from these sites is determined to be ~58 tCO_2e/YR, not 80 tCO_2e/YR.

Conclusion

Project learnings

NAL's intention was to encourage simplification and proliferation of more typical chemical pump conversion practices. NAL had implemented a 4-well SMART pump conversion project in December 2018 and through those learnings was able to devise a more robust and sustainable plan to meet its needs.

Projects such as these can only be successful through good communication between Calgary head office, field operations and field services, in this case:

- Mr. Greg Mangan, Field Instrumentation Lead, Olds Area
- Mr. Levi Ogilvie, District Manager, Techmation Electric & Controls Ltd.
- NAL executive, Olds Area team leadership (Mr. Ben Ross, Field Lead) & engineering (Mr. D. Smith, Facilities)
- Capital (capex) & operations (opex) accounting group

NAL is grateful to all project partners that contributed to the success of these retrofits.

NAL was also an active participant in refurbishing sites with Bluesource, another MCP applicant under the project title "*Bluesource Texsteam Series 51 MCP Program"*. In a similar fashion, both projects focused on the Olds Area, however the Bluesource project endeavoured to optimize 16 sites (31 pumps) for plunger size (1/4" to 3/8") and stroke length alone as an avenue to emission reduction since a larger plunger effectively lessens venting. It is important to note that the Bluesource project captured chemical pump candidates with emission levels above and below the range of emissions evident in the NAL program to broaden perspective on that project-type.

Both project-types; the NAL project and the Bluesource project, were independent activities deploying different actions but with a goal of reduced or eliminated emissions per chemical pump, which has been successfully achieved. Independently, it has been proved that with ample communication and robust record keeping, such retrofit options are viable in today's economic reality.

Technology learnings

This retrofit style is not new. NAL is not espousing a new and unique technique or technology to broadcast to the market. Rather, through good collaboration, learnings on a prior pilot project as well as experience, NAL looked towards already interested groups to work on this project type. NAL believes there is a real market for simple, cost effective solutions and through the MCP Program, NAL was able to retrofit sites that:

- Reside in a production range that live and die by OPEX costs, and
- Do not present as having a lot of actuation and therefore are not likely to attract retrofit dollars or even carbon credit interest if not for this program.

It is evident from working on these retrofits that for other well sites with similar operating attributes, industry can extend production life through such programs instead of being shut-in when equipment failure occurs. This can generate more revenue for the province through royalties and can also spur job action. Furthermore, when these selected wells are suspended, all retrofitted equipment can be mobilized to other sites with similar attributes which is an added benefit.

Appendix

1. It can not be understated as to the ultimate prize for this project-type, *Grid Powered Site Conversions* since in broad terms, using a representative sample of some 30,000 chemical pump sites, there is opportunity to reduce emissions by 1,752,000 tCO2e/YR at an anticipated cost per site of $5,000.00 and emission mitigation of ~58 tCO2e/YR per average pump. This is a massive opportunity and low hanging fruit for industry under the right financing options.

2. In total, NAL instituted 4 different project types involving chemical pump retrofits:

Project Type	**Number of Selected Sites**
1. SMART With Alberta Offset Credits	18
2. Standard Electric (non-SMART) With Alberta Offset Credits	21
3. Standard Electric (non-SMART) Without Alberta Offset Credits (the MCP described herein)	14
4. (Bluesource) Texsteam Series 51 Plunger/Stroke Length Retrofit Program Without Alberta Offset Credits (as briefly described herein)	31
5. 02/10-25-035-07W5 Pneumatic to Spare LCO Head	1
Total	85

NAL is an industry leader in chemical pump retrofit projects.

3. NAL hereby provides salient pictures from 3 sample sites of the 14 locations that realized a retrofit as part of the PTAC MCP Program (see pages 8, 9 & 10 below).

Figure 1: Olds 02-02-031-02 W5 MCP – Standard Electric Final Install (Simplex)

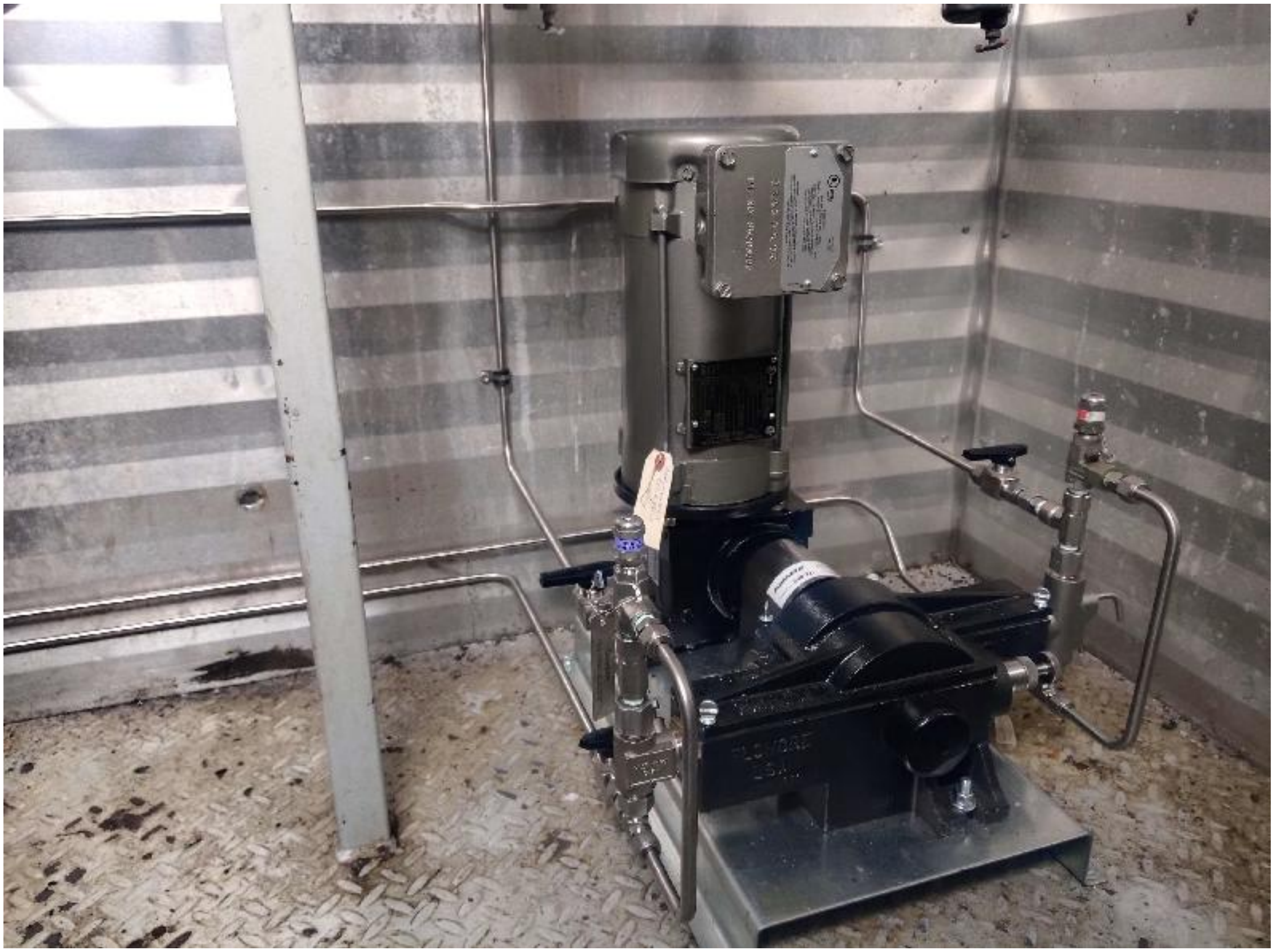

Figure 2: Olds 06-07-033-01W5 MCP – Standard Electric Final Install (Duplex)

Figure 3: Olds 07-02-030-01 W5 MCP– Standard Electric Final Install (Triplex)