Truck Trip Fleet Optimization Study

Final Report | Report Number 18-24 | August 2018

NYSERDA's Promise to New Yorkers:

NYSERDA provides resources, expertise, and objective information so New Yorkers can make confident, informed energy decisions.

Mission Statement:

Advance innovative energy solutions in ways that improve New York's economy and environment.

Vision Statement:

Serve as a catalyst – advancing energy innovation, technology, and investment; transforming New York's economy; and empowering people to choose clean and efficient energy as part of their everyday lives.

Cover Photo Courtesy of Getty Images

Truck Trip Fleet Optimization Study

Final Report

Prepared for:

New York State Energy Research and Development Authority

Albany, NY

David McCabe
Project Manager

Prepared by:

Vnomics

Pittsford, NY

Edward C. McCarthy
Project Director

NYSERDA Report 18-24 | NYSERDA Contract 46852 | August 2018

Notice

Abstract

Vnomics, a New York based company and a provider of advanced fuel analytics solutions for commercial trucking, partnered with Saia, a customer of Vnomics, Rochester Institute of Technology (RIT), and NYSERDA to determine if it was feasible to create a tool that would answer the following two questions for commercial transportation fleets: What truck in my fleet should I send on which task today for the best fleet-wide fuel economy? What trucks should I purchase for the best fuel economy based on my business task mix? The intent was to develop a viable commercial product that would increase Vnomics' business while further reducing the carbon footprint of commercial transportation fleets. Vnomics' telematics data—taken from a subset of Saia's truck fleet by collecting and processing sensor information from the vehicle data bus—would be used to develop and test the algorithms with the help of RIT. Development and test data was collected and processed for various truck configurations, routes, speed, traffic, weather and payloads under real world conditions, so as to ensure that any potential algorithm(s) developed had the broadest potential commercial application. The project was set up with a series of go/no-go serial hypotheses to ensure that if the objectives could not be met, the project would be halted.

Midway through the program, it was determined that the ability to model fuel consumption was possible and that approach using fuzzy logic was the most promising. However, Vnomics did not feel the two defined use cases for a commercial product were achievable with the currently available data and its accuracy. Thus, making the project goal of automating for fuel economy—the way a fleet dispatcher assigns trucks to the "highway" route or the "hilly" route in the hopes of saving meaningful amounts of fuel—is not currently possible with available technology. Furthermore, simple rules of thumb currently used by fleets, such as using new trucks on the highway and routes with the most miles proved to perform quite well and the complexity of our proposed method did not achieve enough fuel savings above the current method to justify its use. However, the findings Vnomics achieved will make further research into truck and route matching for fuel savings easier and will likely be used as a starting point for the next effort once the necessary data is obtainable with sufficient accuracy.

Keywords

advanced fuel analytics solutions, telematics data, vehicle data, model fuel consumption, truck fleet, Vnomics, fuel optimization

Acknowledgments

Vnomics would like to acknowledge the help received from our customer Saia LTL Freight along with the recently deceased Saia industrial engineer, Cedric Bernard Wood Senior, our primary point of contact who tirelessly gathered the truck information necessary to conduct the study. Additionally, we would like to thank the Center for Integrated Manufacturing Studies (CIMS) of the Golisano Institute for Sustainability (GIS) at Rochester Institute of Technology for the technical assistance in this project. Finally, we would like to thank NYSERDA for sponsoring the research as well as the United States Department of Transportation for providing both technical and programmatic assistance.

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Abbreviations and Acronyms

CITY	City Route Context
GIS	Golisano Institute for Sustainability
HWY	Highway Route Context
IDLE	Commercial Truck Idling Context
PMPG	Potential Miles per Gallon
RIT	Rochester Institute of Technology
U.S. DOT	United States Department of Transportation

Definitions

Attribute	Key characteristics of a truck such as engine size, transmission type, that affect fuel performance.
Cab	Used interchangeably with truck
Fuel Consumption	The measured amount of fuel used by a truck and trailer configuration.
Mission	This is the time between key-on to key-off. A mission starts at key-on and ends at key-off. The end of a mission could occur for several reasons such as rest stops for rest room breaks, meal breaks, fueling, etc.
Mission Segment	A portion of a mission.
Potential Miles per Gallon	Potential Miles per Gallon (PMPG) is the potential fuel mileage that could be achieved if the driver drove for fuel purposes in an ideal manner considering engine control, speeding, and idling.
Platform ID	This is the Vnomics' unique identifier of a particular truck such that multiple customers could have the same truck number.
Route	This is the combination of roads the vehicle travels to get from point A to point B.
Route Cluster	A type of route; for example, rural, suburban, urban.
Route Consumption	Consumption of fuel for a prescribed route cluster.
Route Segment	A defined portion of a trip.
Trip	This term is defined by the dispatcher, determining point A and point B. Each trip is comprised of several missions. A trip is also comprised of several route segments.
Trips	The word used in the analysis to define the number of times a truck traverses a route segment.

1 Overview

This final report describes the work performed for the Truck Trip Fleet Optimization Study, NYSERDA Program Opportunity Notice 2881, and Agreement: 46852.

The goal of the project was to determine the feasibility of creating a commercially viable tool that would answer the following two questions:

1. What truck in my fleet should I send on which task for the best fleet-wide fuel economy daily?
2. What trucks should I purchase for the best fuel economy based on my business task mix?

If successful, this tool would be integrated into Vnomics overall fuel optimization product to improve fuel savings and further reduce the carbon footprint of our commercial fleet customers.

In order to determine the feasibility, five hypotheses were developed:

- **Hypothesis 1**
  - $\mathcal{H}_1$: *There are few readily identifiable route clusters that have clear human interpretation (e.g., "city", "rural", etc.).*
  - $\mathcal{T}_1$: Compute distributions of classes with respect to defining characteristics and verify there is a significant discriminability, that class-to-class variance is significantly larger than within-the-class variance.
- **Hypothesis 2**
  - $\mathcal{H}_2$: *Route consumption can be effectively normalized (e.g., by length), which enables comparisons of fuel consumption among different routes. (Load is Critically Important)*
  - $\mathcal{T}_2$: The distribution of consumptions for an individual vehicle, subjected to equivalent (after normalization) routes should have a tight distribution (less than some specified variation, e.g., 5%).
- **Hypothesis 3**
  - $\mathcal{H}_3$: *Normalized fuel consumption of different cab-trailer configurations for given routes are distinguishable and quantifiable.*
  - $\mathcal{T}_3$: Ability to distinguish different configurations for equivalent routes (with a reasonable uncertainty; e.g. 20%).
- **Hypothesis 4**
  - $\mathcal{H}_4$: *Truck assignments can be accurately interpreted as normalized routes.*
  - $\mathcal{T}_4$: Compare the interpreted routes at assignment with those obtained from data analysis.

- **Hypothesis 5**
  - $\mathcal{H}_5$: *The observed consumptions can be used to create sufficiently accurate predictions (variances are less than differences in mean performance of cab-trailer configurations).*
  - $\mathcal{T}_5$: Predict consumption from routes based on the operator's data and compare with actual consumption.

To ensure the money and time invested in this project was spent wisely, after each hypothesis, a go/no-go decision was made to determine if the study had merit. The first three hypotheses were completed successfully, but based on the results of that third gate, it was determined the complexity of the algorithm, the accuracy of the results, and the attainable savings was not enough to justify continuing the project. Therefore, a joint decision was made by all the primary stakeholders to end the project and submit a final report. Despite this decision, overall valuable lessons were learned that can be built on in the future when new collection technology becomes available. The conclusion section identifies and further explains the lessons learned.

This report will be a compilation of links to the previous interim reports, meeting minutes, and presentations and will include new material, findings that resulted in the termination of the project and knowledge gained.

2 Kickoff

The project was kicked off on December 14, 2015. To reduce risk, it was agreed that the project would be split into several steps in conjunction with a sequence of hypotheses validated one at a time with analysis and algorithm development. Each validation step was a go/no-go decision made by answering the question, “Is the productization of a routing tool for fuel savings possible?”. The point of the go/no-go decision was to ensure that the study did not continue if a product could not be realized. The meeting minutes and power point presentation can be found on the NYSERDA Portal under deliverable name 1.1 Meeting Minutes.

Figure 1. NYSERDA Kickoff Meeting Minutes and Presentation

NYSERDA Agreement No. 46852 Meeting Minutes
14 December 2015 2PM – 3PM Vnomics Headquarters Pittsford NY

Executive Summary

1. First monthly report will be submitted in January 2016
2. CNG Trucks will not be used in the analysis as they are not a part of SAIA's fleet
3. RIT subcontract will be finalized prior to the end of December
4. A subcontract with SAIA is not required as there is no flow down of NYSERDA funds
5. Task 3 & 4 have been combined and split as to save money if hypothesis cannot be proven true
6. A go/no-go decision will be made after each hypothesis
7. Milestones still need to match contract values

Attendees

NYSERDA
Joseph Tario, Co-Program Manager

Adam Yagelski, Co-Program Manager
via GoTo meeting

RIT
Sean McConky, Engineer

Nenad Nenadic, Research Lead

Department of Transportation
Robert Ancar

SAIA Motor Freight, LTL
Cedric Wood, Industrial Engineer
Via GoTo Meeting

Vnomics
Edward McCarthy, VP of Operations, NYSERDA Program Manager

Kathleen Watts, NYSERDA Deputy Program Manager

Robert Peckham, Director of Customer Support Services

Actions

Action #	Description	Assigned	Due
A0001	Rework proposed milestone to align with original milestone values	Kathleen Watts	Complete (attached herein)

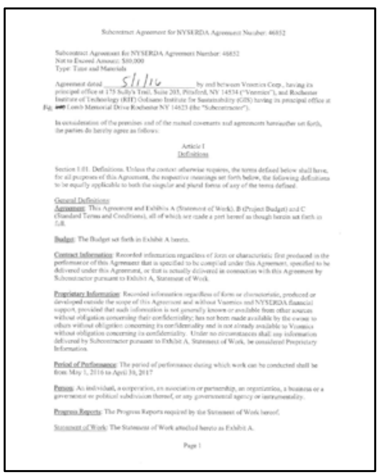
3 Subcontract

A letter of commitment was received from SAIA Motor Freight in September 2015 allowing permission for the project to use Saia data, collected through the use of Vnomics on truck software and hardware, which would be used to validate the algorithms developed for helping fleets optimize the truck-to-route matching process.

The subcontract with Rochester Institute of Technology (RIT), who was providing technical support for the project, was finalized and the signed agreement was provided to NYSERDA on May 5, 2016. As a result, the study was approved by NYSERDA.

The meeting letter and subcontract can be found as follows on the NYSERDA Portal under deliverable name 1.2 Subcontracts.

Figure 2. RIT_NYSERDA Subcontract and Saia Letter of Commitment



Subcontract Agreement for NYSERDA Agreement Number: 46852

Subcontract Agreement for NYSERDA Agreement Number: 46852
Not to Exceed Amount: $80,000
Type: Time and Materials

Agreement dated 5/1/16 by and between Vnomics Corp., having its principal office at 175 Sully's Trail, Suite 205, Pittsford, NY 14534 ("Vnomics"), and Rochester Institute of Technology (RIT) Golisano Institute for Sustainability (GIS) having its principal office at [illegible] Lomb Memorial Drive Rochester NY 14623 (the "Subcontractor").

In consideration of the premises and of the mutual covenants and agreements hereinafter set forth, the parties do hereby agree as follows:

Article I
Definitions

Section 1.01. Definitions. Unless the context otherwise requires, the terms defined below shall have, for all purposes of this Agreement, the respective meanings set forth below, the following definitions to be equally applicable to both the singular and plural forms of any of the terms defined.

General Definitions
Agreement: This Agreement and Exhibits A (Statement of Work), B (Project Budget) and C (Standard Terms and Conditions), all of which are made a part hereof as though herein set forth in full.

Budget: The Budget set forth in Exhibit A hereto.

Contract Information: Recorded information regardless of form or characteristic first produced in the performance of this Agreement that is specified to be compiled under this Agreement, specified to be delivered under this Agreement, or that is actually delivered in connection with this Agreement by Subcontractor pursuant to Exhibit A, Statement of Work.

Proprietary Information: Recorded information regardless of form or characteristic, produced or developed outside the scope of this Agreement and without Vnomics and NYSERDA financial support, provided that such information is not generally known or available from other sources without obligation concerning their confidentiality; has not been made available by the owner to others without obligation concerning its confidentiality and is not already available to Vnomics without obligation concerning its confidentiality. Under no circumstances shall any information delivered by Subcontractor pursuant to Exhibit A, Statement of Work, be considered Proprietary Information.

Period of Performance: The period of performance during which work can be conducted shall be from May 1, 2016 to April 30, 2017

Person: An individual, a corporation, an association or partnership, an organization, a business or a government or political subdivision thereof, or any governmental agency or instrumentality.

Progress Reports: The Progress Reports required by the Statement of Work hereof.

Statement of Work: The Statement of Work attached hereto as Exhibit A.

Page 1

Cedric B. Wood
Industrial Engineer
Saia Motor Freight
11465 Johns Creek Parkway, Suite 400
Johns Creek GA 30097
September 28, 2015

Edward C. McCarthy
Vice President of Operations and Customer Success
Vnomics Corp.
175 Sully's Trail
Pittsford, NY 14534

Dear Ed:

Saia Motor Freight is pleased to partner and provide this letter of commitment to Vnomics for the *"Truck Trip Fleet Optimization Study"* (NYSERDA: Agreement No. 46852). The purpose of which is to assess the feasibility of using Saia data collected through the use of Vnomics software and hardware to help fleets optimize the truck-to-route matching process. Cedric Wood, Industrial Engineer, will be the project lead for Saia and as such will also oversee Saia's support efforts for the project. Saia's role in the project will focus on the testing and validation of the matching process by piloting the software on a mix of vehicles conducting commercial operations from our fleet. As such we will be providing in kind support of the trucks and drivers needed along with management support to test the developed algorithms.

We view this as an excellent opportunity for the Vnomics and Saia team to improve the Vnomics product and demonstrate reduced fuel consumption through better fleet to customer requirements match thereby increasing profit by addressing two important questions about our vehicle mix:

1) What truck in the Saia fleet should we send on which task today for the best fleet wide fuel economy?

2) What trucks should we purchase for the best fuel economy based on Saia's anticipated business task mix?

Look forward to working with the team and please let me know if you have any questions I can reached at (770) 232-4091.

Sincerely,

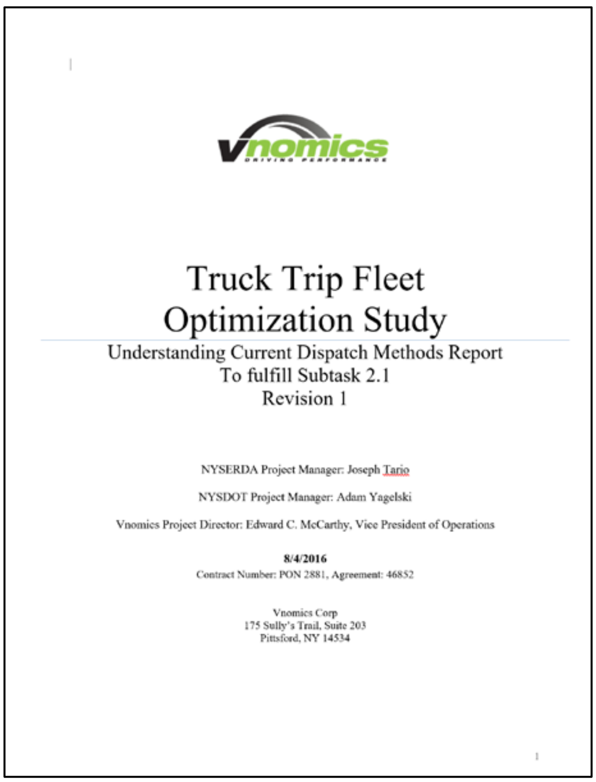
Cedric Wood
Industrial Engineer

4 Understanding Current Dispatch Methods

Vnomics created a 30-question customer survey designed to provide information and an understanding around current transportation fleet dispatch methods. Five fleet managers and dispatchers answered the detailed survey and provided information about their current processes used for truck-to-route assignments as well as their capability to assess routes for different vehicles and driver sustainability. The results of the survey provided a range of truck-to-route assignment processes and other information dispatchers used to describe customer routes.

The report can be found on the NYSERDA Portal under deliverable name 2.1 Task 2 Interim Technical Report.

Figure 3. Truck and Trip Fleet Optimization Study



Truck Trip Fleet
Optimization Study

Understanding Current Dispatch Methods Report
To fulfill Subtask 2.1
Revision 1

NYSERDA Project Manager: Joseph Tario

NYSDOT Project Manager: Adam Yagelski

Vnomics Project Director: Edward C. McCarthy, Vice President of Operations

8/4/2016
Contract Number: PON 2881, Agreement: 46852

Vnomics Corp
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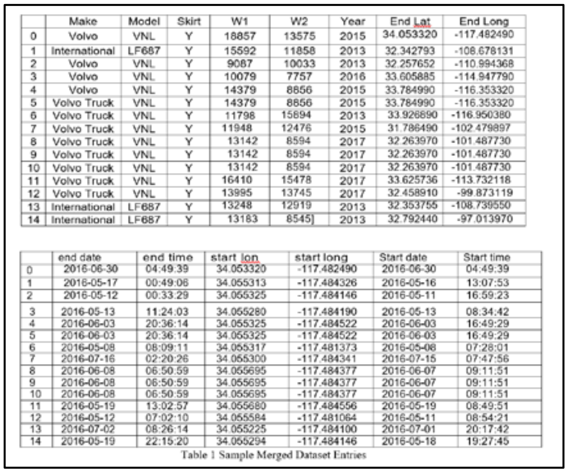
Pittsford, NY 14534

5 Fleet Data Set

The team assembled the route and load information from both onboard truck data and separately collected dispatch data, including load-weight from Saia. From this collection, the team created a merged dataset. To validate this information was properly imported into the system, the collected records were plotted to visualize the data using time-domain and scatter plots. Further, the validity of the latitude and longitude were checked by placing the data on a geo-map to ensure truck positioning and routing were correct. A report was provided describing the methodology by which the disparate information sources were integrated into the data sets and were validated and documented. The report and a description of the vehicles load weight information can be found on the NYSERDA Portal under deliverable name 2.1 Fleet Data Set.

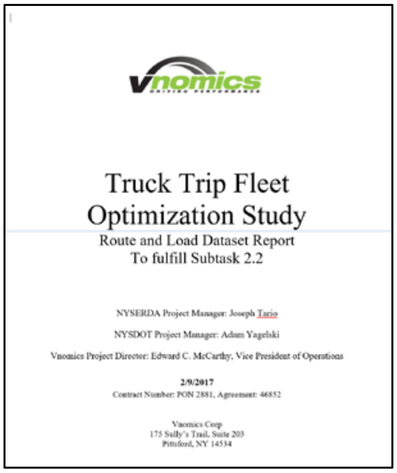
Figure 4. Example Fleet Data Set and Fleet Optimization Route and Load Data Set



	Make	Model	Skirt	W1	W2	Year	End Lat	End Long
0	Volvo	VNL	Y	18857	13575	2015	34.053320	-117.482490
1	International	LF687	Y	15592	11858	2013	32.342793	-108.678131
2	Volvo	VNL	Y	9087	10033	2013	32.257652	-110.994368
3	Volvo	VNL	Y	10079	7757	2016	33.605885	-114.947790
4	Volvo	VNL	Y	14379	8856	2015	33.784990	-116.353320
5	Volvo Truck	VNL	Y	14379	8856	2015	33.784990	-116.353320
6	Volvo Truck	VNL	Y	11798	15894	2013	33.926890	-116.950380
7	Volvo Truck	VNL	Y	11948	12476	2015	31.786490	-102.479897
8	Volvo Truck	VNL	Y	13142	8594	2017	32.263970	-101.487730
9	Volvo Truck	VNL	Y	13142	8594	2017	32.263970	-101.487730
10	Volvo Truck	VNL	Y	13142	8594	2017	32.263970	-101.487730
11	Volvo Truck	VNL	Y	16410	15478	2017	33.625736	-113.732118
12	Volvo Truck	VNL	Y	13995	13745	2017	32.458910	-99.873119
13	International	LF687	Y	13248	12919	2013	32.353755	-108.739550
14	International	LF687	Y	13183	8545]	2013	32.792440	-97.013970

	end date	end time	start lon	start long	Start date	Start time
0	2016-06-30	04:49:39	34.053320	-117.482490	2016-06-30	04:49:39
1	2016-05-17	00:49:06	34.055313	-117.484326	2016-05-16	13:07:53
2	2016-05-12	00:33:29	34.055325	-117.484146	2016-05-11	16:59:23
3	2016-05-13	11:24:03	34.055280	-117.484190	2016-05-13	08:34:42
4	2016-06-03	20:36:14	34.055325	-117.484522	2016-06-03	16:49:29
5	2016-06-03	20:36:14	34.055325	-117.484522	2016-06-03	16:49:29
6	2016-05-08	08:09:11	34.055317	-117.481373	2016-05-08	07:28:01
7	2016-07-16	02:20:26	34.055300	-117.484341	2016-07-15	07:47:56
8	2016-06-08	06:50:59	34.055695	-117.484377	2016-06-07	09:11:51
9	2016-06-08	06:50:59	34.055695	-117.484377	2016-06-07	09:11:51
10	2016-06-08	06:50:59	34.055695	-117.484377	2016-06-07	09:11:51
11	2016-05-19	13:02:57	34.055680	-117.484556	2016-05-19	08:49:51
12	2016-05-12	07:02:10	34.055584	-117.481064	2016-05-11	08:54:21
13	2016-07-02	08:26:14	34.055225	-117.484100	2016-07-01	20:17:42
14	2016-05-19	22:15:20	34.055294	-117.484146	2016-05-18	19:27:45

Table 1 Sample Merged Dataset Entries



Truck Trip Fleet Optimization Study

Route and Load Dataset Report
To fulfill Subtask 2.2

NYSERDA Project Manager: Joseph Tario

NYSDOT Project Manager: Adam Yagelski

Vnomics Project Director: Edward C. McCarthy, Vice President of Operations

2/9/2017

Contract Number: PON 2881, Agreement: 46852

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6 Hypothesis 1

A meeting was held on February 13, 2017 to discuss the work performed for hypothesis 1, the analysis conducted, and the go/no-go recommendations based on the results to gain approval/agreement from all stakeholders including NYSERDA to move forward to hypothesis 2.

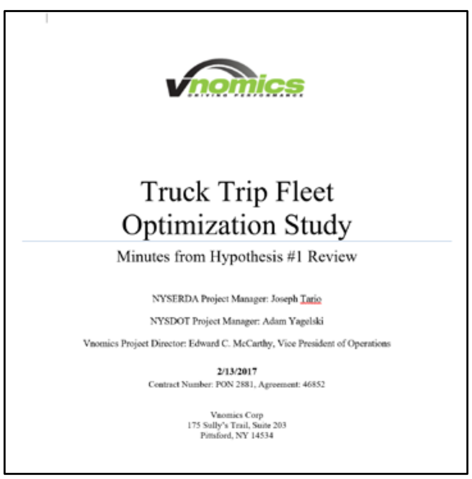
$\mathcal{H}_1$: There are few readily identifiable route clusters that have clear human interpretation (e.g., “city,” “rural,” etc.).

$\mathcal{T}1$: Compute distributions of classes with respect to defining characteristics and verify there is a significant discriminability, that class-to-class variance is significantly larger than within-the-class variance. During the investigation of hypothesis 1, the team was able to come to the following two conclusions:

- Older trucks are clearly distinguishable for fuel purposes for the road types that were categorized, described, and analyzed.
- All trucks, both old and new, that were analyzed by the team were distinguishable for fuel purposes on mixed road types.

Approval to proceed and begin work on Hypothesis 2 was given by NYSERDA with U.S. Department of Transportation (U.S. DOT) concurrence. The report and minutes from this meeting can be found on the NYSERDA Portal under deliverable name 3.1 Vehicle Attribute Listing.

Figure 5. Minutes Hypothesis #1 Review and Hypothesis #1 Presentation


Truck Trip Fleet Optimization Study

Minutes from Hypothesis #1 Review

NYSERDA Project Manager: Joseph Tario

NYSDOT Project Manager: Adam Yagelski

Vnomics Project Director: Edward C. McCarthy, Vice President of Operations

2/13/2017

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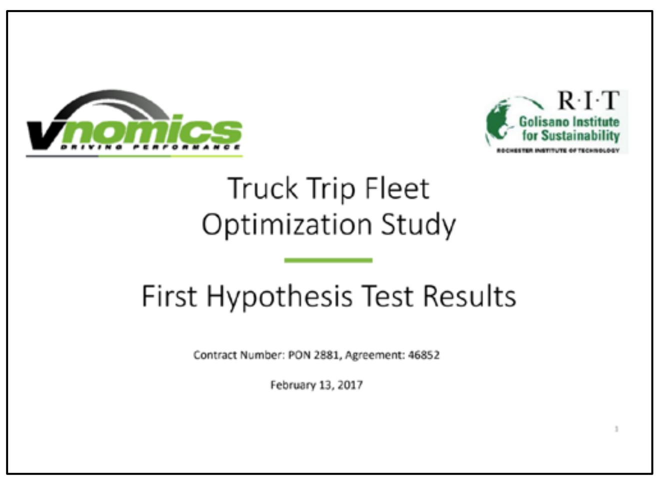


7 Hypothesis 2

A meeting was held on May 31, 2017 to discuss the work performed for hypothesis 2, the analysis conducted, and the go/no-go recommendations based on the results to gain approval/agreement from all stakeholders including NYSERDA to move forward to hypothesis 3.

$\mathcal{H}_2$: Route consumption can be effectively normalized (e.g., by length), which enables comparisons of fuel consumption among different routes. (Load is Critically Important).

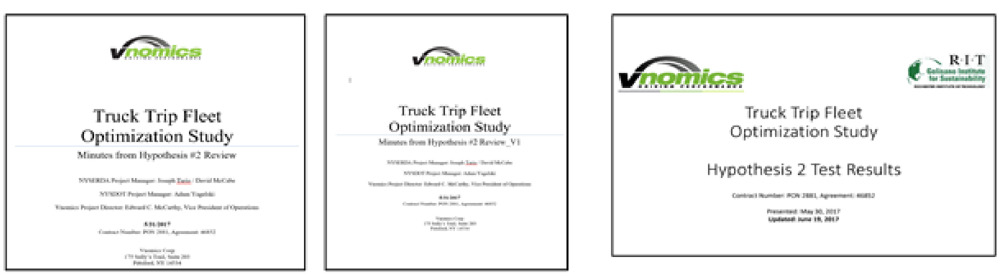
$\mathcal{T}_2$: The distribution of consumptions for an individual vehicle, subjected to equivalent (after normalization) routes should have a tight distribution (less than some specified variation, e.g., 5%).

The team was able to come to the following conclusions:

- Initial analysis found encouraging results:
    - There was a significant difference in the fuel performances of different truck configurations for some contexts (“HWAY”)
    - However, there was indistinguishable performance for others (“IDLE,” “CITY”)
- These results were plausible from the viewpoint of the configurations’ attributes
- The findings were statistically validated
- Early attempts to distill a better clustering of operating conditions were not successful
- Quantification of benefits needs improved resolution
- Decomposing of missions into segments, by context, is a promising approach

Approval to proceed forward in the project and to begin the work on hypothesis 3 was given by NYSERDA with U.S. DOT concurrence. The report and minutes from this meeting can be found on the NYSERDA Portal under deliverable name 3.2 Task 3 Interim Technical Report.

Figure 6. Hypothesis #2 Minutes, Hypothesis #2 Version 1, and Hypothesis #2 Presentation



8 Hypothesis 3

A meeting was held on December 8, 2017 to discuss the work performed for hypothesis 3, the analysis conducted, the go/no-go recommendations based on the results, and to gain approval/agreement from NYSERDA to move forward to hypothesis 4.

$\mathcal{H}_3$: Normalized fuel consumption of different cab-trailer configurations given routes are distinguishable and quantifiable.

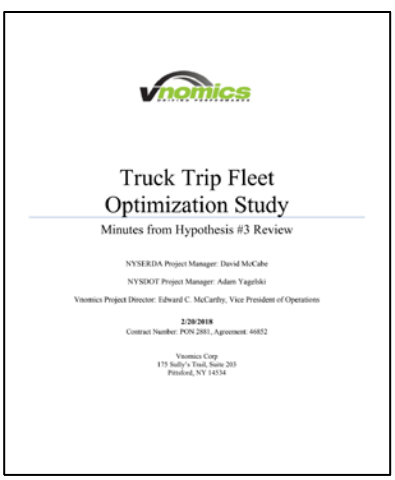
$\mathcal{T}_{3:}$ Ability to distinguish different configurations for equivalent routes (with a reasonable uncertainty; e.g., ~20%).

The team was able to come to the following conclusions:

- Decomposing of missions into segments was not a promising approach
- The ability to create a product for truck fleet optimization is not viable—the only algorithms that had any success was a black box fuzzy logic approach that did not allow for meaningful interpretation.
- There was benefit in performing the study as some lessons were learned that may be useful once collection technology and accuracy improves on vehicle.

Based on the conclusions, it was determined the study should be ended, and the final report submitted. The report and minutes from this meeting can be found on the NYSERDA Portal under deliverable name 4.3 Task 4 Interim Technical Report.

Figure 7. Hypothesis #3 Minutes and Hypothesis #3 Presentation



Truck Trip Fleet
Optimization Study
Minutes from Hypothesis #3 Review

NYSERDA Project Manager: David McCabe
NYSDOT Project Manager: Adam Yagelski
Vnomics Project Director: Edward C. McCarthy, Vice President of Operations

2/20/2018
Contract Number: PON 2881, Agreement: 46852

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9 Conclusion

It was not feasible to create a tool that would answer the following two questions:

1. What truck in my fleet should I send on which task today for the best fleet wide fuel economy?
2. What trucks should I purchase for the best fuel economy based on my business task mix?

Lessons Learned

Vnomics found the ability to model fuel consumption was possible and that approach using fuzzy logic was the most promising. However, we did not feel the two defined use cases, for a commercial product, were achievable with the available data and its accuracy. The required detail about a trip to correctly predict fuel consumption is not simple to gather data, and the only successful algorithm within our accuracy criteria required data and attributes that was not human identifiable. This makes the goal of automating, for fuel economy, the way a fleet dispatcher assigns trucks to the “highway” route or the “hilly” route in the hopes of saving meaningful amounts is not currently possible with available technology. Furthermore, simple rules of thumb currently used by fleets, such as use new trucks on the highway and routes with the most miles proved to perform quite well and the complexity of our proposed method did not achieve enough fuel savings above the current method to justify its use. However, the findings Vnomics achieved will make further research into truck and route matching for fuel savings easier and will likely be used as a starting point for the next effort once the necessary data is obtainable and accurate. While not as simple as characterizing routes and predicting fuel economy a more complex multivariable fuel economy model is likely possible with our current system. With a sufficiently accurate fuel economy model, Vnomics believes fleets could test questions like “What would the fuel savings be if my whole fleet operation was running Model X tractor last year” without running a single test mile. This could lead to more informed truck (truck configuration) buying decisions that lead to tailoring of fleet trucks to their customer base, loads, and routing. Additionally, this approach could be used to develop a “digital twin” (digital replica of truck and truck configurations) and could lead to significant fuel economy optimization and test savings for any fleet. Additionally, running continuous fuel economy models on all tractors could allow for fleets to see undetectable deviations (from developed digital twins) in expected fuel economy as early warning for maintenance issues on their tractors. In conclusion, while the final goal of a path to a commercial product was not achieved, Vnomics believes the derived learning will feed future R&D and continue to allow Vnomics, NYSERDA, and other stakeholders to advance the understanding of fuel efficiency and optimization in the U.S. commercial trucking market.

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