Red, White and Green: Investigating the Energy Intensity of Wine Distribution

International Conference of Business and Sustainability
Portland State University, November 2nd, 2007

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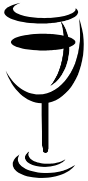
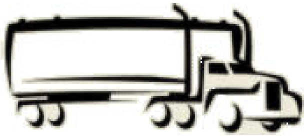
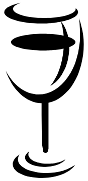


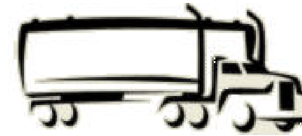
Agenda



- Problem Motivation and Definition
- Introduction to the U.S. Wine Market
- A Sample Network and Scenarios
- Analysis Methodology
- Results
- Conclusions and Future Research



Problem Motivation and Definition

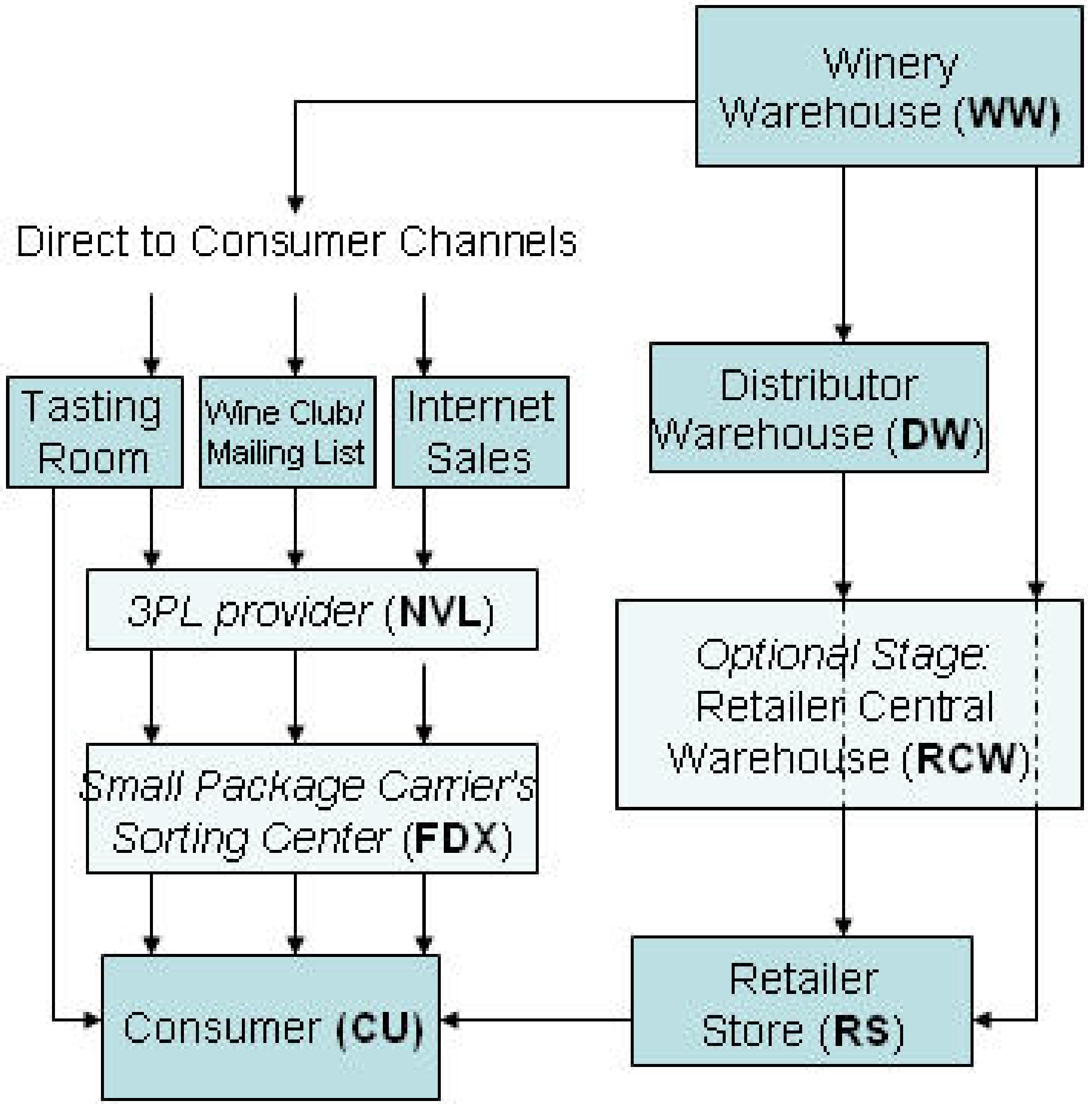


- Greenhouse gas emissions are in the news
- Wine is a luxury product purchased by consumers increasingly concerned about sustainability
  - We consider the small producer of moderate to expensive wines
- Aspects of wine industry are energy intensive
  - Model frame is post-production logistics: transportation and storage from winery to end consumer
  - Alternate storage and distribution formats beyond the scope of consideration

Overview of U.S. Wine Market

- Most wine is sold through the three tier distribution system
  - Some wineries can self-distribute within California
  - Chain retail stores often consolidate shipments at a regional warehouse
- Direct-to-Consumer sales of wine are increasing, especially for higher priced wines
  - Multiple channels for direct sales exist
  - A growing market for wine related 3PL services
- Wine is a food product
  - Temperature controlled transit and storage facilities

The Supply Chain for U.S. Wineries



Network and Scenarios

- Consider the hypothetical situation of a Sonoma winery that sells 200 half-cases (6 bottles) of wine to consumers located in San Francisco over the course of 3 months
  - Many wineries have clubs where members sign up to receive predefined allotments of wine every quarter
  - The wine in question is assumed to be a higher end wine that may not be widely available in stores
- We create scenarios to model potential fulfillment options


WW
NVL
RCW
RS, CU
FDX
DW
Sebastopol
Yountville
Rohnert Park
Glen Ellen
Sonoma
Napa
Vacaville
Fairfield
Suisun City
Petaluma
American Canyon
Novato
Vallejo
San Pablo Bay
Benicia
Suisun Bay
Rodeo
Martinez
Pittsburg
Antioch
San Anselmo
San Rafael
Hercules
Concord
Golden Gate National Recreation Area
Larkspur
Richmond
Clayton
Mill Valley
El Cerrito
Walnut Creek
Mt Diablo State Park
Berkeley
Tiburon
Sausalito
Moraga
Danville
San Francisco
Oakland
San Ramon
Alameda
Castro Valley
Dublin
Daly City
San Leandro
South San Francisco
Hayward
Pacifica
Millbrae
Union City
Burlingame
San Mateo
Newark
Fremont
Montara
Moss Beach
San Carlos
101
116
121
12
29
113
37
80
680
780
1
13
92
880

Scenario Summary

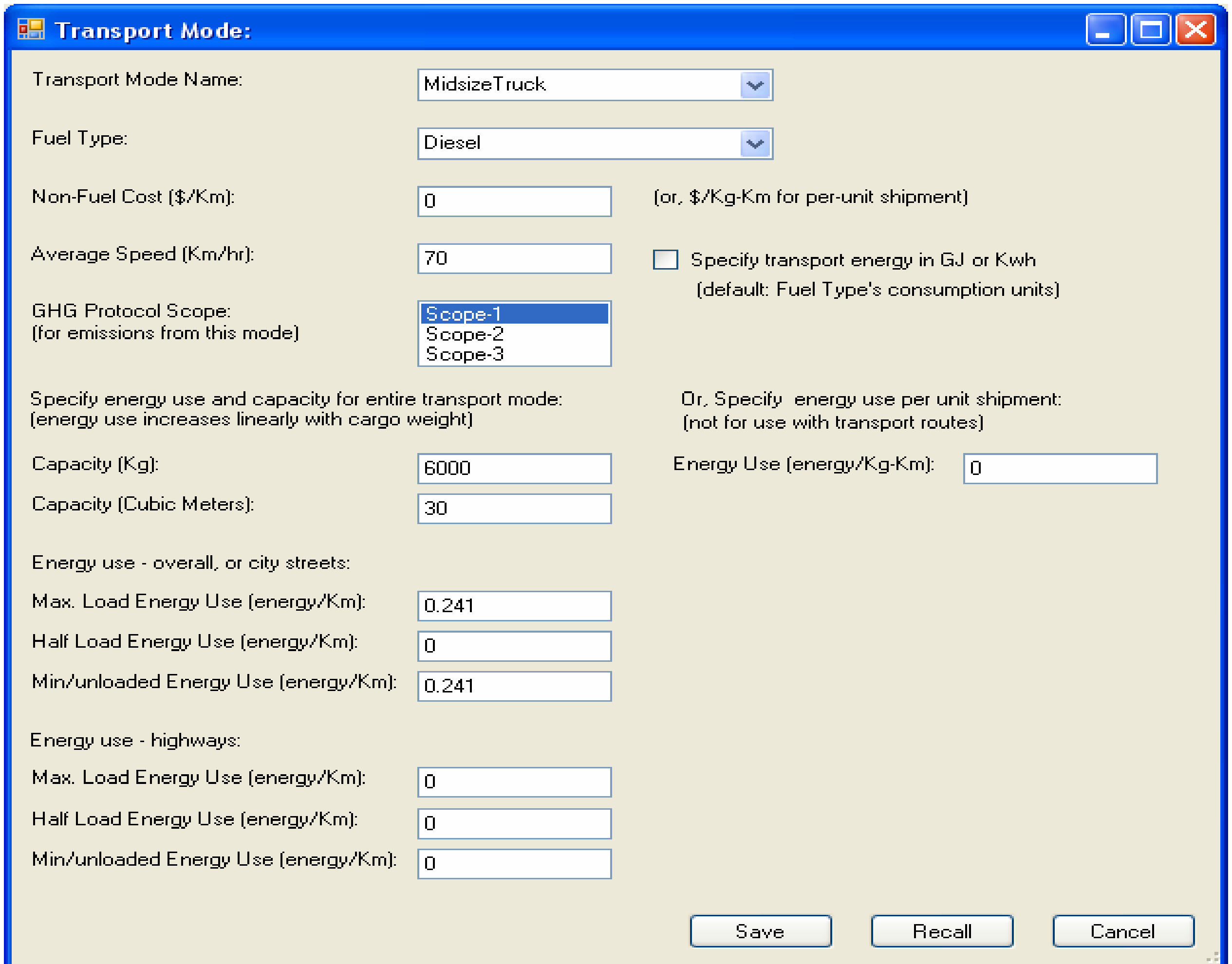
- We construct four different scenarios
- As appropriate, storage facilities are also considered

Scenario 1: 3 Tier Distribution		Scenario 2: Self-Distribution		Scenario 3: 3PL Fulfillment		Scenario 4: Consumer Drives	
Transport (km)		Transport (km)		Transport (km)		Transport (km)	
WW->DW	224	WW->RCW	121.6	WW->NVL	57.6	WW->CU	144
DW->RCW	96	RCW->RS	64	NVL->FDX	150.4		
RCW->RS	64	RS->CU	7.2	FDX->CU	16		
RS->CU	7.2						

Our Analytic Tool: SEAT

- An interactive software package designed to analyze supply chains through a bounded event-driven simulation method
- Calculates the energy usage, costs and carbon dioxide emissions for each echelon of the network given:
  - Transport modes, vehicle types and load utilization
  - Distances between echelons
  - Refrigeration energy requirements
  - Other industry data and estimates
- More info at www.suryatech.com/ep

SEAT: Transport Parameters


Transport Mode:

Transport Mode Name: MidsizeTruck

Fuel Type: Diesel

Non-Fuel Cost ($/Km): 0 (or, $/Kg-Km for per-unit shipment)

Average Speed (Km/hr): 70 ☐ Specify transport energy in GJ or Kwh (default: Fuel Type's consumption units)

GHG Protocol Scope: (for emissions from this mode) Scope-1 / Scope-2 / Scope-3

Specify energy use and capacity for entire transport mode: (energy use increases linearly with cargo weight)

Or, Specify energy use per unit shipment: (not for use with transport routes)

Capacity (Kg): 6000

Energy Use (energy/Kg-Km): 0

Capacity (Cubic Meters): 30

Energy use - overall, or city streets:

Max. Load Energy Use (energy/Km): 0.241

Half Load Energy Use (energy/Km): 0

Min/unloaded Energy Use (energy/Km): 0.241

Energy use - highways:

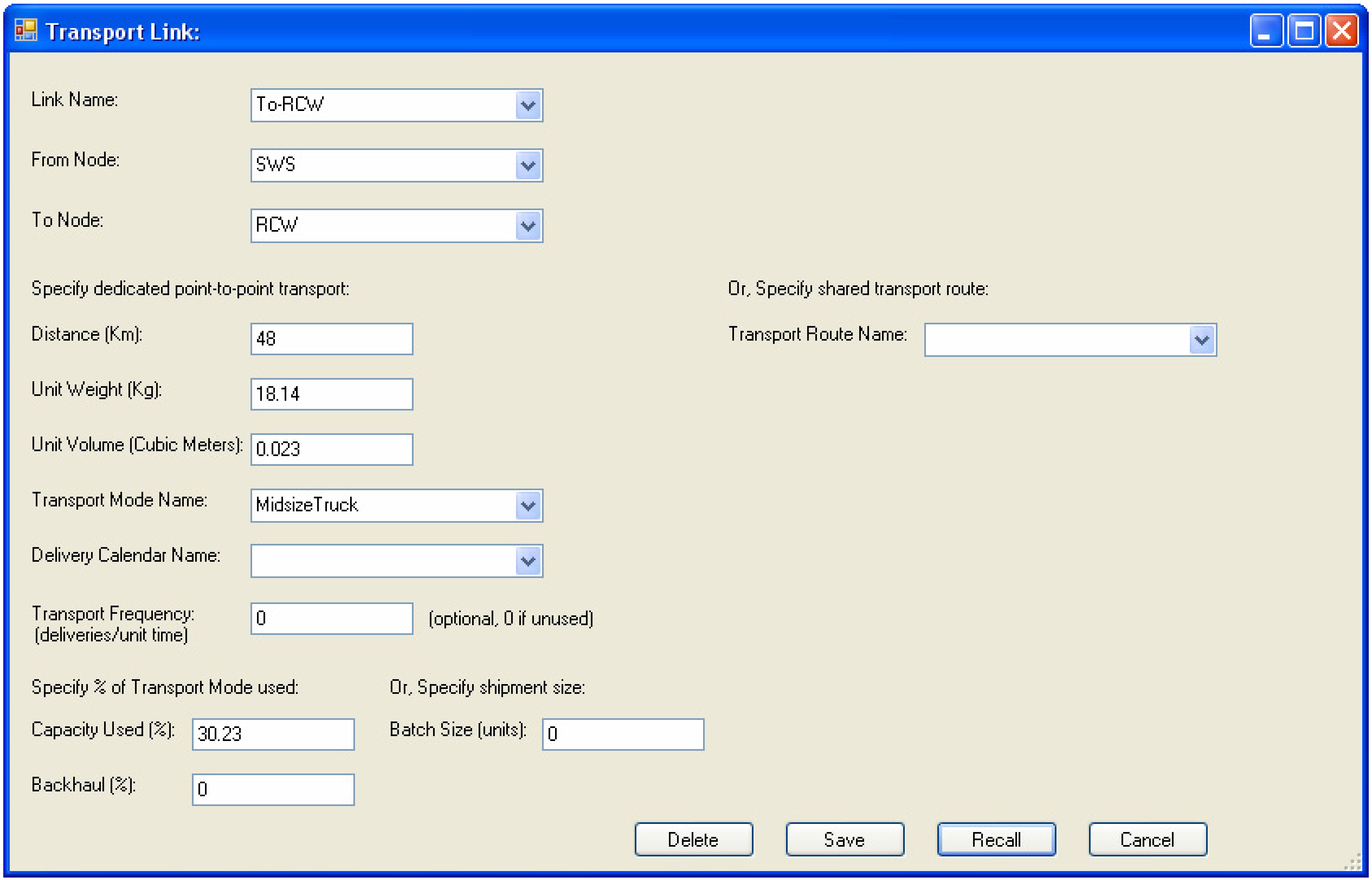
Max. Load Energy Use (energy/Km): 0

Half Load Energy Use (energy/Km): 0

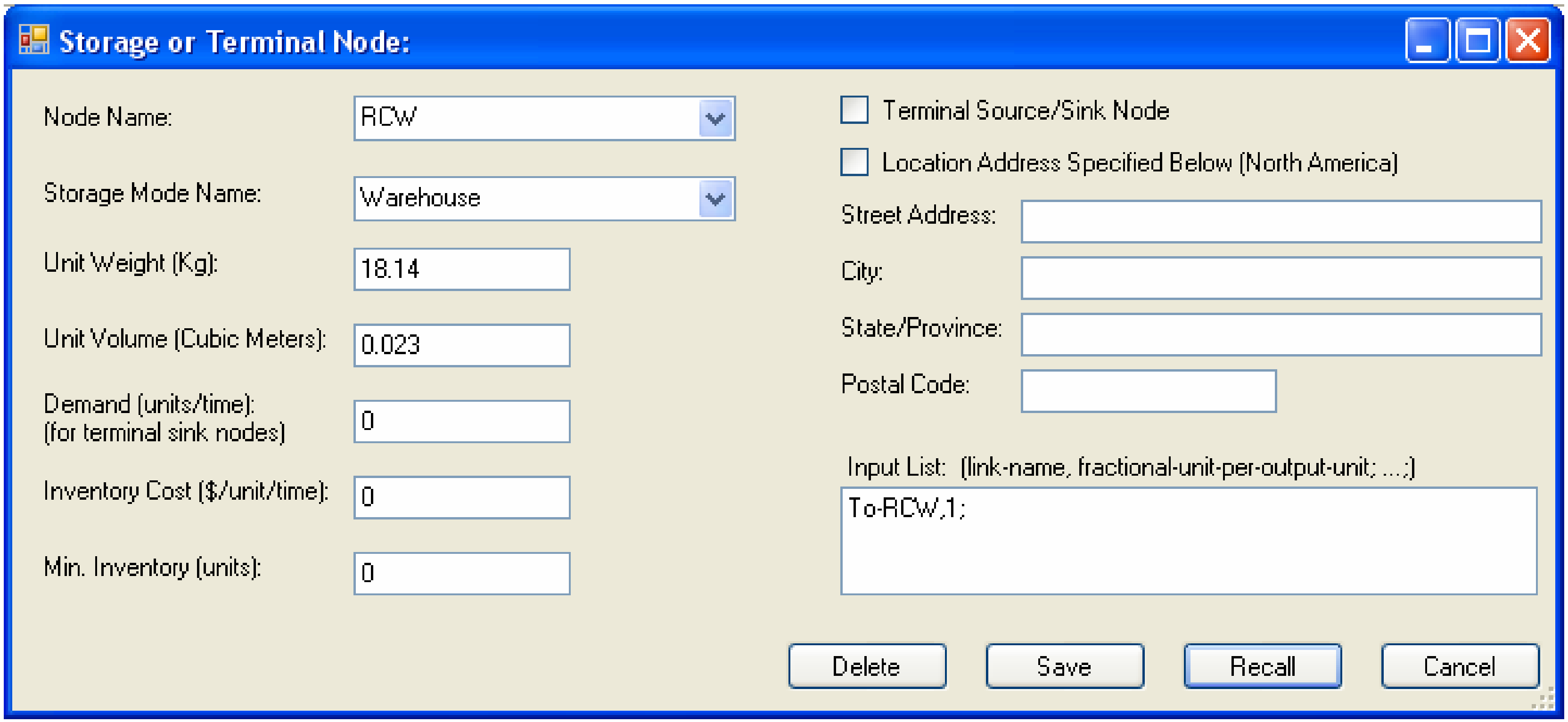
Min/unloaded Energy Use (energy/Km): 0

Save | Recall | Cancel

SEAT: Transport Link



SEAT: Storage Node



SEAT: Output

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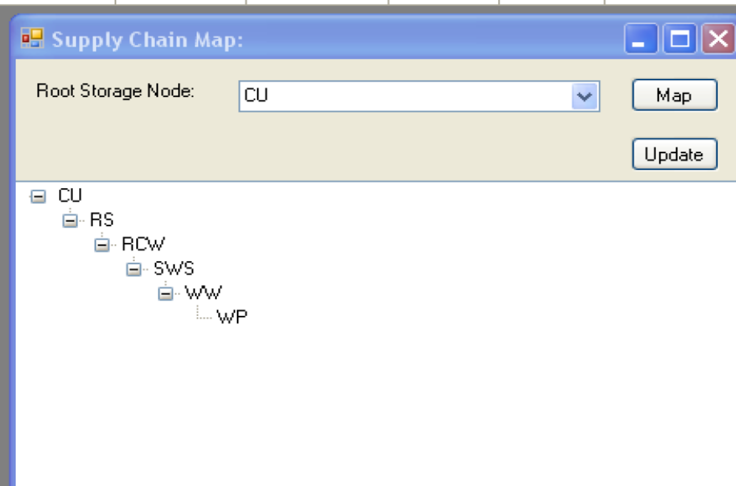
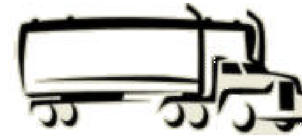
	Node/Link	Mode	Energy/Fuel	Distance (Km)	Delivery Period (Weeks)	Batch Size or Ave. Inventory	Energy Used per Week	Emissions Generated per Week	Energy/Fuel Cost per Week ($)	Transportation Overhead Cost per Week ($)	Storage Overhead Cost per Week ($)	Total Cost per Week ($)
	To-SWS	MidsizeTruck (Transport)	Diesel	224.00	13.00	99.99	0.04658	3.4472	0.88	0.00		0.88
	To-RCW	MidsizeTruck (Transport)	Diesel	96.00	13.00	99.99	0.01996	1.4774	0.38	0.00		0.38
	To-RS	LightTruck (Transport)	Diesel	64.00	4.30	33.08	0.08670	6.4163	1.64	0.00		1.64
	To-CU	Car (Transport)	Gasoline	7.20	0.07	0.50	0.40678	28.1693	8.28	0.00		8.28
	SWS	Warehouse (Storage)	Electricity			0.00	0.00000	0.0000	0.00		0.00	0.00
	RCW	Warehouse (Storage)	Electricity			33.58	0.08576	14.4906	2.38		0.00	2.38
	RS	Store (Storage)	Electricity			16.29	0.04160	7.0287	1.16		0.00	1.16
	WW	Warehouse (Storage)	Electricity			0.00	0.00000	0.0000	0.00		0.00	0.00
	<TOTAL>						0.68737	61.0296	14.71	0.00	0.00	14.71
▶*												



Results

- For each scenario the energy usage, emissions and costs for transport and storage are given by echelon, then tallied for total and per case usage
- Common assumptions:
  - No backhauling, save for package delivery vehicles
  - Consumers’ trips dedicated to wine pickup
  - Refrigerated Storage costs and energy usage accrued only for time product dwells at that echelon
  - Storage at consumer site ignored

Results: 3 Tier Distribution



- Wine assumed to pass through all echelons, but reside longest at the retail level
- Consumer pickup the largest contributor of CO_2

Type	Node/Link	km	Mode	Energy (GJ)	Emissions (Kg CO2)	Energy/ Fuel Cost($)
transport	WW->DW	224	Midsized Truck	0.61	44.81	11.44
transport	DW->RCW	96	Midsized Truck	0.26	19.21	4.94
transport	RCW->RS	64	Light Truck	1.13	83.41	21.32
transport	RS->CU	7.2	Car	5.29	366.20	107.64
storage	WW			0.00	0.00	0
storage	DW			0.00	0.00	0
storage	RCW			1.11	188.38	30.94
storage	RS			0.54	91.37	15.08
			for all 100 cases:	8.94	793.38	$ 191.36
			by case:	0.09	7.93	$ 1.91

Results: Winery Self Distribution

- Remove wholesaler, less backtracking in transit
- CO_2 emissions at 95% of previous scenario

Type	Node/Link	km	Mode	Energy (GJ)	Emissions (Kg CO2)	Energy/ Fuel Cost($)
transport	WW->RCW	122	Midsized Truck	0.39	24.31	$ 6.24
transport	RCW->RS	64	Light Truck	1.17	83.46	$ 21.32
transport	RS->CU	7.2	Car	5.33	366.21	$ 107.64
storage	WW			0.00	0.00	$ -
storage	RCW			1.11	188.38	$ 30.94
storage	RS			0.54	91.37	$ 15.08
			for all 100 cases:	8.55	753.73	$ 181.22
			by case:	0.09	7.54	$ 1.81

Results: Fulfillment via 3PL

- Wine stored at 3PL (NewVine Logistics) then processed through a small package carrier service (FedEx)
- While the elimination of consumers' trips provides significant savings, even without this consideration 3PL fulfillment remains the most efficient

Type	Node/Link	km	Mode	Energy (GJ)	Emissions (Kg CO2)	Fuel Cost($)
transport	WW->NVL	57.6	Midsized Truck	0.13	11.57	$ 2.99
transport	NVL->FDX	150	Midsized Truck	0.39	30.03	$ 7.67
transport	FDX->CU	16	LightTruck-Parc	0.26	20.93	$ 5.33
storage	WW			0.00	0.00	$ -
storage	NVL			1.11	187.10	$ 30.81
storage	FDX			0.00	0.00	$ -
			for all 100 cases:	1.89	249.63	$ 46.80
			by case:	0.02	2.50	$ 0.47

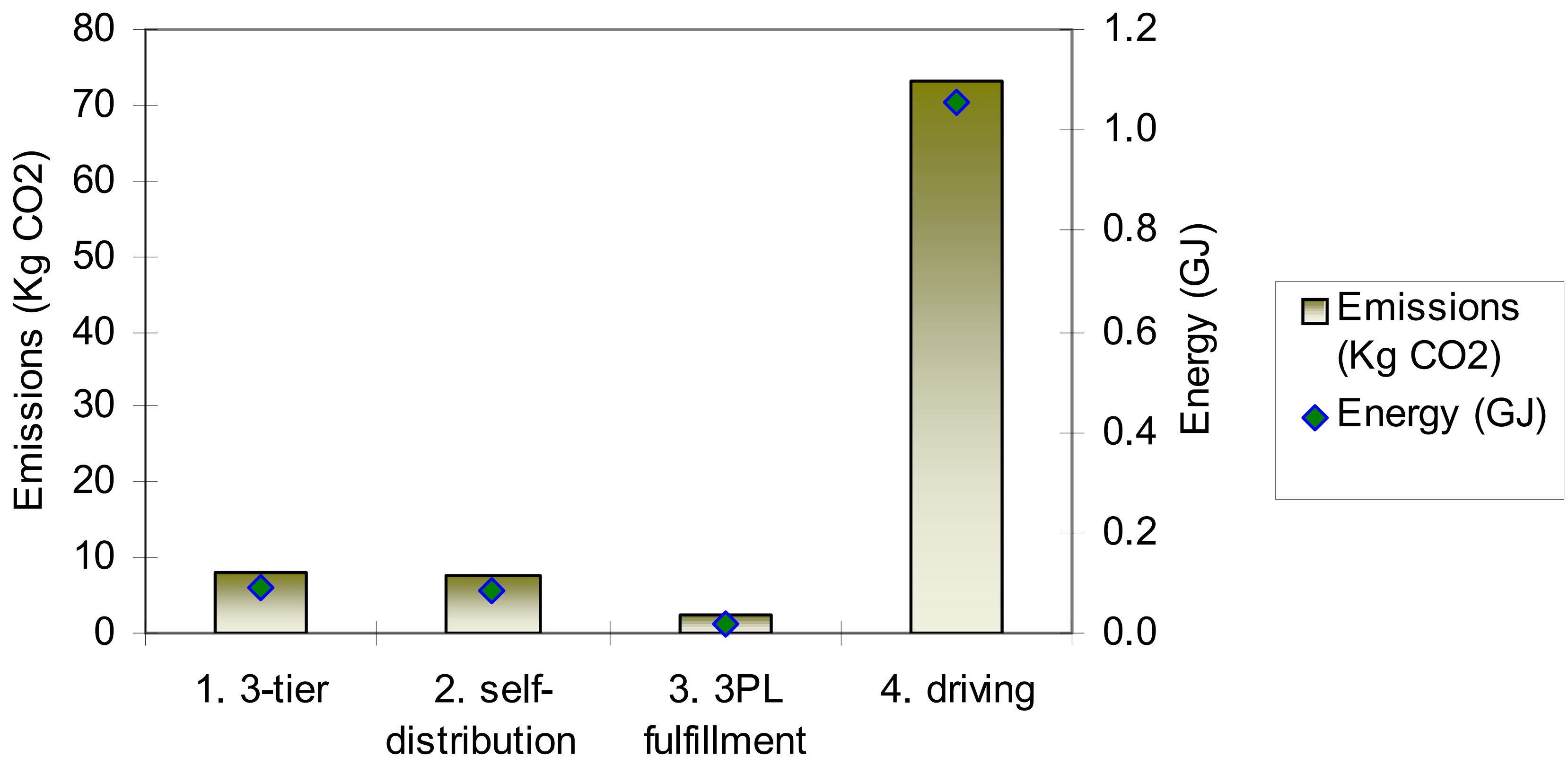
Results: Drive to Winery

- A customer driving to the winery produces over nine times the emissions as the 3-tier scenario
  - A hybrid car still produces 4 times as much emissions
- While this scenario does not mirror realistic consumer behavior, it serves to illustrate the inefficiencies of non-consolidated transit of goods

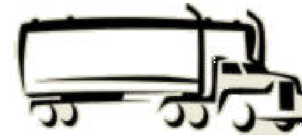
Type	Node/Link	km	Mode		Energy (GJ)	Emissions (Kg CO2)	Energy/ Fuel Cost($)
transport	WW->CU	144	car		105.76	7324.02	$ 2,152.2
				by case:	1.06	73.24	$ 21.52

Comparing the Scenarios

- Per Case CO_2 Emissions and Energy Use by Scenario

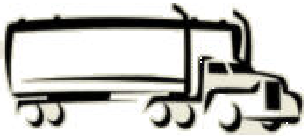


Interesting Implications



- For our local network, direct to consumer shipment is the most energy and emissions efficient fulfillment method
  - Contradicts common popular press assumptions
- Per case emissions contribution from all consolidated transit stages less than that from consumers' driving
  - Other researchers have found similar results
  - Extension to the question of "food miles"- long distances for transported food may have less impact than consumers' purchasing behavior and proximity to the store
- Will always face the problem of accounting for consumers' driving
  - Especially problematic as this stage is the least measurable and least controllable

Future Research



- Perform case studies for specific wineries and logistics providers
- Consider longer distance supply chain scenarios
  - Is direct fulfillment still the most efficient? Less likely if air transit must be utilized
- Our current work assumes the facilities and policies are fixed
  - Investigate designing a supply chain, optimizing the number and placement of echelons as well as inventory and transit policies

In Conclusion

- Greenhouse gas emissions are going to continue to receive increasing media and business attention
- Many of the measures being proposed are not cost effective or, in the long run, are not even likely to reduce net emissions
- We recommend using the “science of better” to assess and improve energy and emissions usage
- We welcome questions or comments
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Thank You