

Economics of Energy Independence

An example semantically linking DOE and other data
using Executable Open Vocabulary English

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Agenda

- Making smart connections
 - Apps connect people and data
- A wiki for content in open vocabulary, Executable English
 - write applications as rules in English, run them, and get explanations
- An example semantically linking DOE and other data
 - energy independence
- Summary

Making Smart Connections

Good things happen when we make smart connections:

Software----- **Linux** -----hardware

People----- **Google** -----all the web pages on the net

Buyers----- **Ebay** -----sellers

People----- **Executable English Apps** ----- open networked data

Making Smart Connections

data.gov

data.gov has over 400,000 datasets

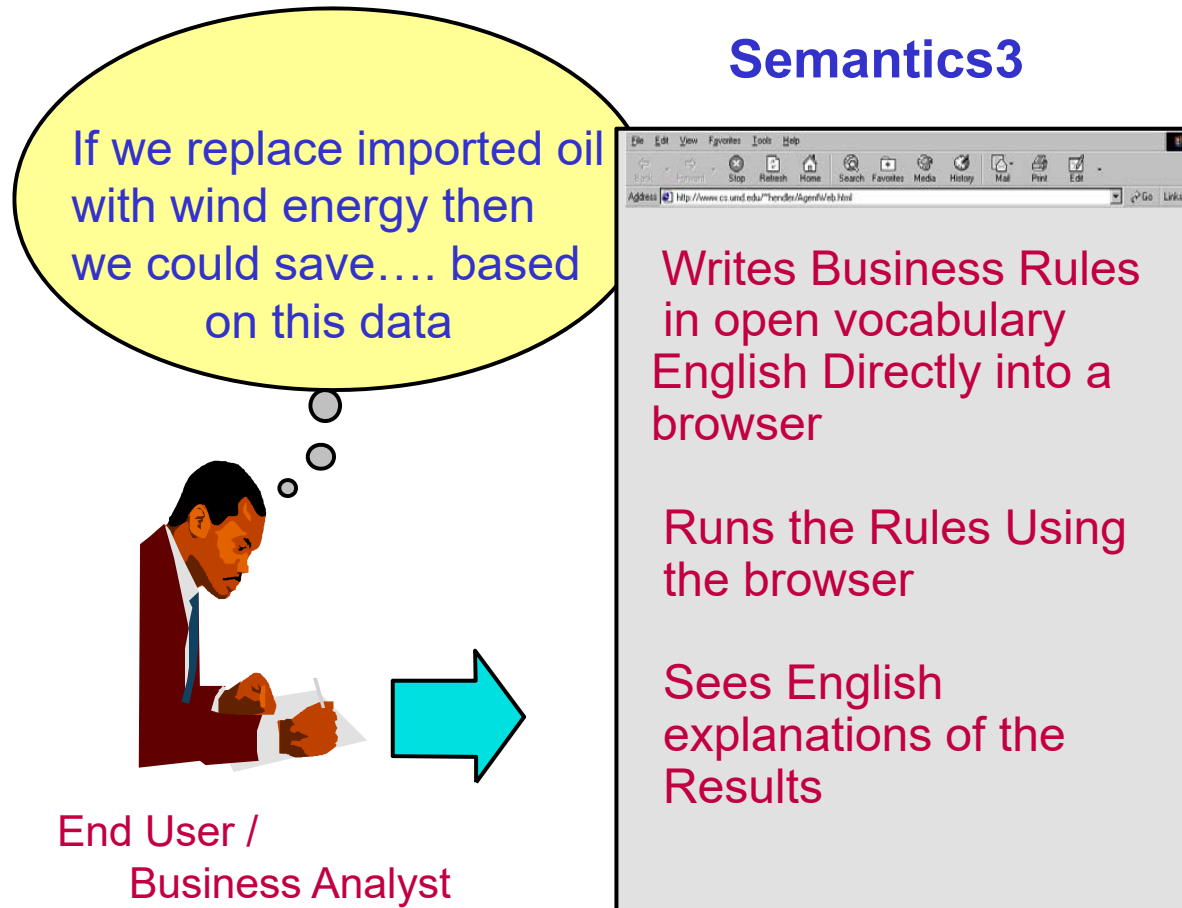
- Raw data in many different formats
- Plus many data extraction tool UIs
- Mostly useful only to developers
- More than 1,000 apps and counting

Applications assign useful *meaning* to data

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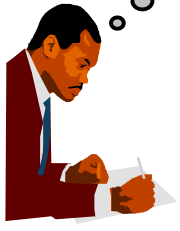
A Wiki for content in executable open vocabulary English



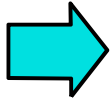
A Wiki for content in executable open vocabulary English

Semantics3

If we replace imported oil with wind energy then we could save.... based on this data



End User /
Business
Analyst



Writes Business Rules in open vocabulary English Directly into a browser

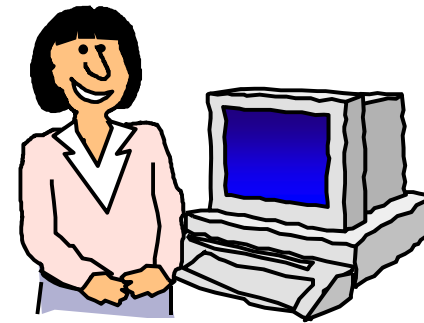
Runs the Rules Using the browser

Sees English explanations of the Results

Semantics2



Theory of
Declarative
Knowledge

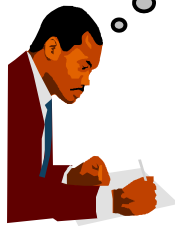


Programmer

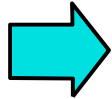
A Wiki for content in executable open vocabulary English

Semantics3

If we replace imported oil with wind energy then we could save.... based on this data



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Writes Business Rules in open vocabulary English Directly into a browser

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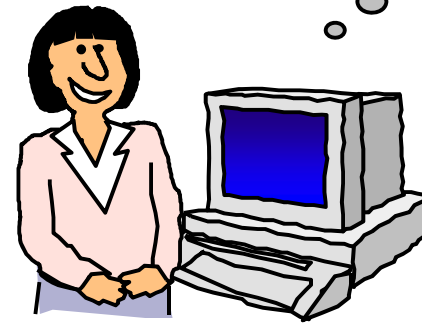
Internet Business Logic

Application Independent Engine

Semantics2



Theory of Declarative Knowledge



Programmer

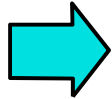
A Wiki for content in executable open vocabulary English

Semantics3

How much can we save in 2030 by switching to?



End User / Business Analyst



Writes Business Rules in open vocabulary English Directly into a browser

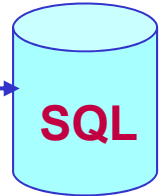
Runs the Rules Using the browser

Sees English explanations of the Results

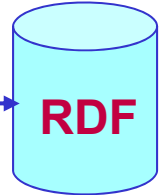
Internet Business Logic

Application Independent Engine

Semantics1



SQL

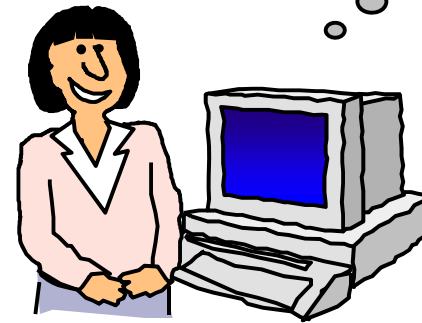


RDF

Semantics2



Theory of Declarative Knowledge



Programmer

A Wiki for content in executable open vocabulary English

- The vocabulary is open, and so -- to a large extent -- is the syntax
 - *not* yet-another-controlled-English-system
- No external dictionary or grammar maintenance is needed
- Strict English semantics is achieved via a trade off
 - if you want two English sentences to mean the same thing, you must say so
 - you must use place holders, such as “some-name” and “a-number”
- But, you are free to write executable English knowledge containing...
 - technical terms or jargon -- Wildcat, Upstream, Mud (oil industry)
 - government acronyms and usage -- SRB, Single Regeneration Budget
 - logical expressions -- (A c,t) [that-C c t => (E c1) [that-C1 c1 t and c partof c1 at t]]
- Although the system is open vocabulary, it can be used to query and manage:
 - controlled vocabularies, taxonomies and ontologies
 - Data in RDF (Resource Description Format) – single table with 3 columns

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Semantically linking DOE and other data

Potential savings from energy independence

Data from DOE and other sources

Levelized Cost Comparison for New Generating Capacity in the United States
(2004 Dollars per Megawatthour)

Cost Element	Technology			
	Coal	Natural Gas	Wind	Nuclear
Capital . . .	30.4	11.4	40.7	42.7
O&M.	4.7	1.4	8.3	7.8
Fuel	14.5	36.9	0.0	6.6
Total^a. . .	53.1	52.5	55.8	59.3

-- www.eia.doe.gov/oiaf/archive/ieo06/special_topics.html

Some corresponding Internet Business Logic facts:

estimated cost of electricity from this-source is this-amount \$/MWh

=====

```
coal          53.1
natural gas   52.5
wind          55.8
nuclear       59.3
```

Semantically linking DOE and other data

Potential savings from energy independence

Data from DOE and other sources, plus a simple classification

Internet Business Logic facts:

```
this-fuel can be classified as being of type this-type
```

```
=====
```

Aviation Gasoline	Liquids
Coal Anthracite	Coal
Coal Bituminous	Coal
Coal Lignite	Coal
Coal Subbituminous	Coal
Distillate Fuel Oil and Diesel	Liquids
Flare Gas	Natural Gas

Semantically linking DOE and other data

Potential savings from energy independence

Data from DOE and other sources

Table A3. Energy Prices by Sector and Source
(2007 Dollars per Million Btu, Unless Otherwise Noted)

Sector and Source	Reference Case							Annual Growth 2007-2030 (percent)
	2006	2007	2010	2015	2020	2025	2030	
Residential								
Liquefied Petroleum Gases	23.88	24.98	24.79	32.03	32.52	33.39	34.92	1.5%
Distillate Fuel Oil	18.46	19.66	17.74	23.46	24.12	24.97	26.71	1.3%
Natural Gas	13.70	12.69	11.96	11.97	12.50	13.05	14.33	0.5%
Electricity	31.21	31.19	30.75	31.76	32.70	34.06	35.90	0.6%
Commercial								
Liquefied Petroleum Gases	21.20	23.04	21.61	28.80	29.24	30.08	31.58	1.4%
Distillate Fuel Oil	15.02	16.05	15.22	21.50	22.06	22.93	24.70	1.9%
Residual Fuel Oil	8.88	10.21	10.34	16.01	16.66	17.05	17.99	2.5%
Natural Gas	11.90	10.99	10.42	10.55	11.13	11.72	12.97	0.7%
Electricity	28.38	28.07	27.14	27.11	28.12	29.25	31.10	0.4%

-- www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf

Corresponding Internet Business Logic facts:

this-group	this-fuel	this-06	this-07	this-10	this-15	this-20	this-25	this-30 (\$/MillionBtu)
Residential	Liquefied Petroleum Gases	23.88	24.98	24.79	32.03	32.52	33.39	34.92
Residential	Distillate Fuel Oil	18.46	19.66	17.74	23.46	24.12	24.97	26.71
Residential	Natural Gas	13.70	12.69	11.96	11.97	12.50	13.05	14.33
Residential	Electricity	31.21	31.19	30.75	31.76	32.70	34.06	35.90
Commercial	Liquefied Petroleum Gases	21.20	23.04	21.61	28.80	29.24	30.08	31.58
Commercial	Distillate Fuel Oil	15.02	16.05	15.22	21.50	22.06	22.93	24.70
Commercial	Residual Fuel Oil	8.88	10.21	10.34	16.01	16.66	17.05	17.99
Commercial	Natural Gas	11.90	10.99	10.42	10.55	11.13	11.72	12.97
Commercial	Electricity	28.38	28.07	27.14	27.11	28.12	29.25	31.10

Semantically linking DOE and other data

Potential savings from energy independence

An Executable English rule that semantically links DOE and other data

as a step towards energy independence, the US would like to reduce oil imports by some-number barrels per year

to convert from Quadrillion Btu to barrels of gasoline, multiply by some-factor

that-number / that-factor = some-quadrillion-btu

to change Quadrillion Btu to gigawatt-hours, multiply by some-btu-gwh-factor

those-quadrillion-btu * that-btu-gwh-factor = some-number-gigawatt-hours

that-number-gigawatt-hours * 1000 = some-number-megawatt-hours

estimated cost of electricity from some-source is some-quantity \$/MWh <---- DOE data

that-number-megawatt-hours * that-quantity = some-\$amount

that-\$amount / 1000000000 = some-long-amount

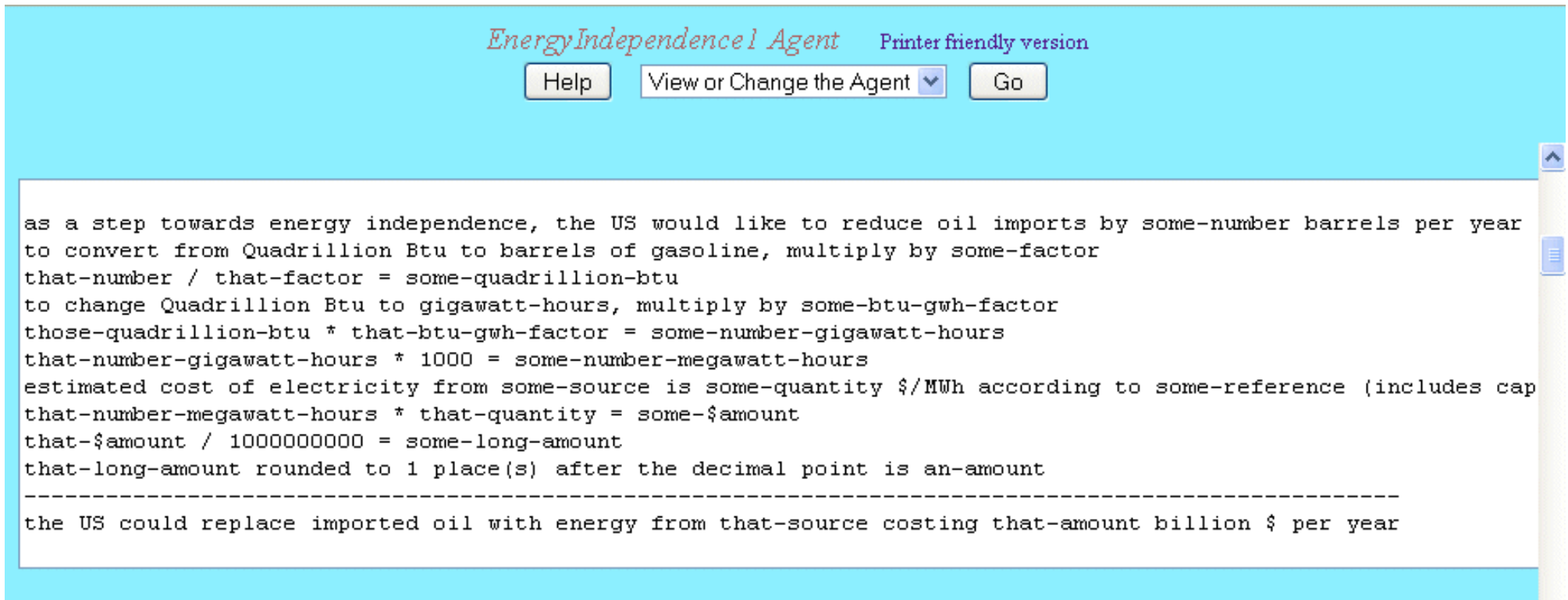
that-long-amount rounded to 1 place(s) after the decimal point is an-amount

the US could replace imported oil with energy from that-source costing that-amount billion \$ per year

Semantically linking DOE and other data

Potential savings from energy independence

The rule in an editable web page



The screenshot shows a web page for the 'EnergyIndependence1 Agent'. At the top, there is a navigation bar with the text 'EnergyIndependence1 Agent' and a link for 'Printer friendly version'. Below this are three buttons: 'Help', 'View or Change the Agent' (with a dropdown arrow), and 'Go'. The main content area is a text editor with a light blue background and a white border. It contains a series of text-based rules for a semantic agent. The rules describe a process for calculating potential savings from energy independence by converting oil imports to gigawatt-hours and then to a cost per year. The rules are as follows:

```
as a step towards energy independence, the US would like to reduce oil imports by some-number barrels per year
to convert from Quadrillion Btu to barrels of gasoline, multiply by some-factor
that-number / that-factor = some-quadrillion-btu
to change Quadrillion Btu to gigawatt-hours, multiply by some-btu-gwh-factor
those-quadrillion-btu * that-btu-gwh-factor = some-number-gigawatt-hours
that-number-gigawatt-hours * 1000 = some-number-megawatt-hours
estimated cost of electricity from some-source is some-quantity $/MWh according to some-reference (includes cap
that-number-megawatt-hours * that-quantity = some-$amount
that-$amount / 1000000000 = some-long-amount
that-long-amount rounded to 1 place(s) after the decimal point is an-amount
-----
the US could replace imported oil with energy from that-source costing that-amount billion $ per year
```

To view, edit and run this example, go to www.executable-english.com and select EnergyIndependence1

Semantically linking DOE and other data

Potential savings from energy independence

Question menu, generated from the rules

EnergyIndependence1 Question Menu

Type a question here, then press Enter to reorder the menu

or select a question from the menu below:

- switching from imported oil to energy from some-source could potentially save the US some-number billion \$ per year by 2030
- the US could replace imported oil with energy from some-source costing some-amount billion \$ per year
- as a step towards energy independence, the US would like to reduce the cost of oil imports by some-total billion 2007 \$ by 2030
- as a step towards energy independence, the US would like to reduce oil imports by some-number barrels per year
- to convert from Quadrillion Btu to barrels of gasoline, multiply by some-factor
- to change Quadrillion Btu to gigawatt-hours, multiply by some-btu-gwh-factor
- liquid fuel has an average price of some-amount in 2030 (2007 \$ per Million Btu)
- the US would like to reduce oil imports from some-country by some-amount barrels per year
- some-fuel of type Liquids is priced at some-price in 2030 (2007 \$ per Million Btu)
- some-fuel of type Liquids is priced at some-price1 in 2007 and at some-price in 2030 (2007 \$ per Million Btu)
- some-group some-fuel is priced at some-price1 in 2007 and at some-price2 in 2030 (2007 \$ per Million Btu)
- adding some-number1 to some-number2 and rounding to 1 place gives some-number

To view, edit and run this example, go to www.executable-english.com and select *EnergyIndependence*¹⁷

Semantically linking DOE and other data

Potential savings from energy independence

Selected question

EnergyIndependence1 Question Menu

Type a question here, then press Enter to reorder the menu

or select a question from the menu below:

switching from imported oil to energy from some-source could potentially save the US some-number billion \$ per year by 2030

the US could replace imported oil with energy from some-source costing some-amount billion \$ per year

as switching from imported oil to energy from some-source could potentially save the US some-number billion \$ per year by 2030

as a step towards energy independence, the US would like to reduce oil imports by some-number barrels per year

to convert from Quadrillion Btu to barrels of gasoline, multiply by some-factor

to change Quadrillion Btu to gigawatt-hours, multiply by some-btu-gwh-factor

liquid fuel has an average price of some-amount in 2030 (2007 \$ per Million Btu)

the US would like to reduce oil imports from some-country by some-amount barrels per year

some-fuel of type Liquids is priced at some-price in 2030 (2007 \$ per Million Btu)

some-fuel of type Liquids is priced at some-price1 in 2007 and at some-price in 2030 (2007 \$ per Million Btu)

some-group some-fuel is priced at some-price1 in 2007 and at some-price2 in 2030 (2007 \$ per Million Btu)

adding some-number1 to some-number2 and rounding to 1 place gives some-number

To view, edit and run this example, go to www.executable-english.com and select *EnergyIndependence*¹⁸

Semantically linking DOE and other data

Potential savings from energy independence

Specialization menu, generated from the rules

EnergyIndependence1 Question Menu

Type a question here, then press Enter to reorder the menu

or select a question from the menu below:

switching from imported oil to energy from some-source could potentially save the US some-number billion \$ per year by 2030

the US could replace imported oil with energy from some-source costing some-amount billion \$ per year

as switching from imported oil to energy from some-source could potentially save the US some-number billion \$ per year by 2030

as a step towards energy independence, the reduce oil imports by some-number barrels per year

to convert from Quadrillion Btu to barrels of by some-factor

to change Quadrillion Btu to gigawatt-hours -btu-gwh-factor

liquid fuel has an average price of some-amount in 2030 (2007 \$ per Million Btu)

the US would like to reduce oil imports from some-country by some-amount barrels per year

some-fuel of type Liquids is priced at some-price in 2030 (2007 \$ per Million Btu)

some-fuel of type Liquids is priced at some-price1 in 2007 and at some-price in 2030 (2007 \$ per Million Btu)

some-group some-fuel is priced at some-price1 in 2007 and at some-price2 in 2030 (2007 \$ per Million Btu)

adding some-number1 to some-number2 and rounding to 1 place gives some-number

coal
natural gas
nuclear
wind

To view, edit and run this example, go to www.executable-english.com and select EnergyIndependence¹⁹

Semantically linking DOE and other data

Potential savings from energy independence

Answer

EnergyIndependence1 Answer (4 rows found) [Printer friendly version](#)

[Help](#)

[Go to the Question Menu](#)

[Go](#)

switching from imported oil to energy from this-source could potentially save the US this-number billion \$ per year by 2030

<input checked="" type="radio"/>	coal	246.5
<input type="radio"/>	natural gas	248.4
<input type="radio"/>	nuclear	226.9
<input type="radio"/>	wind	238.0

Semantically linking DOE and other data

Potential savings from energy independence

Explanation -- hypertexted

EnergyIndependence1 Explanation

Help

Go to the Answer Page

Go

as a step towards energy independence, the US would like to reduce the cost of oil imports by 414.647 billion 2007 \$ by 2030

the US could replace imported oil with energy from coal costing 168.1 billion \$ per year

$414.647 - 168.1 = 246.547$

246.547 rounded to 1 place(s) after the decimal point is 246.5

switching from imported oil to energy from coal could potentially save the US 246.5 billion \$ per year by 2030

as a step towards energy independence, the US would like to reduce oil imports by 1928232000 barrels per year

to convert from Quadrillion Btu to barrels of gasoline, multiply by $1.78571e+08$

$1928232000 / 1.78571e+08 = 10.7981$

liquid fuel has an average price of 38.4 in 2030 (2007 \$ per Million Btu)

$38.4 * 1000000000 = 3.84e+10$

$10.7981 * 3.84e+10 = 4.14647e+11$

$4.14647e+11 / 1000000000 = 414.647$

as a step towards energy independence, the US would like to reduce the cost of oil imports by 414.6470092800001 billion 2007 \$ by 2030

Semantically linking DOE and other data

Data Sources Used

www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf

tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbb1_m.htm

www.eia.doe.gov/oiaf/archive/ieo06/special_topics.html

www.physics.uci.edu/~silverma/units.html

```
this-fuel can be classified as being of type this-type
```

```
=====
```

Aviation Gasoline	Liquids
Coal Anthracite	Coal
Coal Bituminous	Coal
Coal Lignite	Coal
Coal Subbituminous	Coal
Distillate Fuel Oil and Diesel	Liquids
Flare Gas	Natural Gas

Google indexes and searches applications that are written in English

Search: for estimated demand that-id fraction of the order

The screenshot shows a Mozilla browser window with the title "for estimated demand that-id fraction of the order - Google Search - Mozilla". The address bar contains the URL "http://www.google.com/search?hl=en&q=for+estimated+demand+that-id+fraction+of+the+order+&btnG=Goog". The search results page displays the Google logo, navigation links for "Web", "Images", "Groups", "News", "Froogle", "Local", and "more". The search query is entered in the search box, and the results show "Results 1 - 10 of about 679 for for **estimated demand that-id fraction of the order** . (0.33 seconds)". A "Did you mean" suggestion is provided: "for estimated demand that-**is** fraction of the order". Under the "Scholarly articles" section, three articles are listed: "Data-Driven and Demand-Driven Computer Architecture - by Treleven - 102 citations", "Budget constrained frontier measures of fiscal equality ... - by Grosskopf - 48 citations", and "Underinvestment, Debt Financing, and Long-Term Supplier ... - by Subramaniam - 1 citations". A snippet from "www.reengineeringllc.com/demo_agents/Oil-IndustrySupplyChain1.agent" is shown, along with a PDF link: "[PDF] Oil Industry Supply Chain Management Using English Business Rules ...".

Google indexes and searches applications that are written in English

Search: for estimated demand that-id fraction of the order

for estimated demand that-id fraction of the order - Google Search - Mozilla

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop <http://www.google.com/search?hl=en&q=for+estimated+demand+that-id+fraction+of+the+order+&btnG=Goog> Search

Home Bookmarks Sign in

Google Web Images Groups News Froogle Local more »

for estimated demand that-id fraction of the order Search [Advanced Search](#) [Preferences](#)

Web Results 1 - 10 of about 679 for **for estimated demand that-id fraction of the order** . (0.33 seconds)

Did you mean: [for estimated demand that-is fraction of the order](#)

Scholarly articles for **for estimated demand that-id fraction of the order**

- [Data-Driven and Demand-Driven Computer Architecture](#) - by Treleven - 102 citations
- [Budget constrained frontier measures of fiscal equality ...](#) - by Grosskopf - 48 citations
- [Underinvestment, Debt Financing, and Long-Term Supplier ...](#) - by Subramaniam - 1 citations

[An Oil Industry Supply Chain Example Version 20050524 || You can ...](#)
... in some-month of some-year for **estimated demand that-id** some-fraction of the **order** will be some-product from some-refinery that-quantity * that-fraction ...
www.reengineeringllc.com/demo_agents/Oil-IndustrySupplyChain1.agent - 7k - [Cached](#) - [Similar pages](#)

[\[PDF\] Oil Industry Supply Chain Management Using English Business Rules ...](#)
File Format: PDF/Adobe Acrobat - [View as HTML](#)
for **estimated demand that-id** some-fraction of the **order** will be some-product from some-refinery. that-quantity * that-fraction = some-amount ...
www.reengineeringllc.com/Oil_Industry_Supply_Chain_by_Kowalski_and_Walker.pdf - [Similar pages](#)

The executable English rules and facts that define the application

A paper that describes the application

Summary

- Making smart connections
 - apps connect people and data
- A wiki for content in Executable open vocabulary English
 - socially write apps in English using a browser
 - run the apps, and get explanations, again using a browser
 - (also, run the system in SOE mode from Java client programs)
- An example semantically linking DOE and other data
 - energy independence
- Google indexes and searches apps that are written in English

Links

1. There is an overview paper at www.executable-english.com/A_Wiki_for_Business_Rules_in_Open_Vocabulary_Executable_English.pdf

2. Semantics2 -- what a reasoner **should** do:

Backchain iteration: towards a practical inference method that is simple enough to be proved Terminating, sound and complete. Journal of automated reasoning, 11:1-22

3. The English inferencing example

EnergyIndependence1

(and many other examples provided) can be run, changed, and re-run as follows:

1. Point a firefox or chrome browser to www.executable-english.com
2. Click on [Internet Business Logic](#)
3. Click on the go button
4. Click on the help button to see how to navigate through the pages
5. Select *EnergyIndependence1*

4. You are cordially invited to write and run your own examples. Shared use of the system is free

5. To make the system part of an SOA architecture, you can download and extend the java client stub <http://www.executable-english.com/iblclient1.Java>

About Adrian Walker

- Author of over 20 papers, and an Addison-Wesley book, on rules systems and databases
- Assistant professor at Rutgers university
- Manager of principles and applications of logic programming, IBM Yorktown research laboratory
- Manager, internet development at Eventra
(A manufacturing supply chain company)
- http://en.wikipedia.org/wiki/Adrian_Walker_%28computer_scientist%29