

# Benefits of Publishing the Norwegian Petroleum Directorate's FactPages as Linked Open Data

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NIK 2013  
19 November 2013



NPD and NPD FactPages

Linked Open Data

Converting NPD's FactPages to Semantic Web Data

Examples

- Map Visualization

- Query Formulation

NPD and NPD FactPages

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Examples

Map Visualization

Query Formulation

# Norwegian Petroleum Directorate (NPD)

## What is it?

- A governmental specialist directorate and administrative body
- Reports to the Ministry of Petroleum and Energy
- Main objective is to look after the national interests in the energy sector
- One of four functions:

*The NPD has a national responsibility for data from the Norwegian continental shelf. The NPD's data, overview and analyses constitute a crucial factual basis on which the activities are founded*

- The FactPages contain data about petroleum activities on the NCS
- Data is collected from companies that operate on the NCS
- Important functions:
  - forms the basis for the authorities' planning of future activity and their judgement of existing activity
  - makes companies share information
  - provides information to the general public
- Acts as a national reference data library for the activities on the NCS

[Home](#) [NPD](#) [Show link](#) [Help](#) [Norsk](#)

### FACTPAGES

NORWEGIAN PETROLEUM DIRECTORATE

Wellbore Licence BAA Field Discovery Company Seismic Facility TUF Pipeline Stratigraphy
Synchronized 21.10.2013 - 03:58


- Attributes
- Page view
  - All
  - PDO approved
  - Producing
  - Shut down
  - Ordered by..
- Table view
  - Overview
  - Status
  - Operators
  - Owners
  - Licensees
  - Production
  - Reserves
  - Investments
  - Description
  - Geography

SIGYN  
 SKARV  
 SKIRNE  
 SKULD  
 SLEIPNER VEST  
 SLEIPNER ØST  
 SNORRE  
 SNØHVIT  
 STATFJORD  
 STATFJORD NORD  
 STATFJORD ØST  
 SVALIN  
 SYGNA  
 TAMBAR  
 TAMBAR ØST  
 TOMMELITEN GAMMA  
 TOR  
 TORDIS  
 **TROLL**  
 TRYM  
 TUNE  
 TYRIHANS  
 ULA  
 URD  
 VALE  
 VALEMOM  
 VALHALL

Hide details Show details Map Feedback Download/Export ▶

Current activity status	PRODUCING
Discovery wellbore	<a href="#">31/2-1</a>
Discovery year	1979

**Picture**



**Discoveries included**

Discovery name
<a href="#">31/2-1 TROLL VEST</a>
<a href="#">31/6-1 TROLL ØST</a>

**Activity status - history**

Status	Status from	Status to
PRODUCING	19 09 1995	

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### FACTPAGES

NORWEGIAN PETROLEUM DIRECTORATE

11 main categories

Wellbore
Licence
BAA
Field
Discovery
Company
Seismic
Facility
TUF
Pipeline
Stratigraphy

Synchronized 21.10.2013 - 03:58


Attributes  
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[Hide details](#) [Show details](#) [Map](#) [Feedback](#) [Download/Export](#)

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### FACTPAGES

NORWEGIAN PETROLEUM

Home NPD Show link Help Norsk

11 main categories

Synchronized 21.10.2013 - 03:58

Wellbore
Licence
BAA
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Discovery
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Stratigraphy

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WELLBORE 43-1

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**Activity status - history**

Status	Status from	Status to
PRODUCING	19 09 1995	

6 / 20

UiO : Universitetet i Oslo



### FACTPAGES

NORWEGIAN PETROLEUM

Home NPD Show link Help Norsk

Selecting Field ... 11 main categories

Synchronized 21.10.2013 - 03:58

Wellbore Licence BAA **Field** Discovery Company Seismic Facility TUF Pipeline Stratigraphy


- Attributes
- Page view
- All
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Status	Status from	Status to
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... lists available views and subviews. Selecting Page view → All ...

FACTPAGES  
NORWEGIAN PETROLEUM

Home NPD Show link Help Norsk

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... lists recorded members for the view. Selecting TROLL ...

FACTPAGES  
NORWEGIAN PETROLEUM

Home NPD Show link Help Norsk

Selecting Field ... 11 main categories

Wellbore Licence BAA **Field** Discovery Company Seismic Facility TUF Pipeline Stratigraphy

Synchronized 21.10.2013 - 03:59

- Attributes
- Page view
  - All
  - PDO approved
  - Producing
  - Shut down
  - Ordered by..
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  - Overview
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- SIGYN
- SKARV
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- TUNE
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... lists recorded members for the view. Selecting TROLL ...

Hide details Show details Map Feedback Download/Export ▶

Current activity status	PRODUCING
Discovery wellbore	<a href="#">31/2-1</a>
Discovery year	1979

**Picture**



**Discoveries included**

Discovery name	<a href="#">31/2-1 TROLL VEST</a>
	<a href="#">31/2-1 TROLL ØST</a>

... displays a (page view) report, i.e., all data, about the field Troll

us from	Status to
1979	Q 1995

**FACTPAGES**  
NORWEGIAN PETROLEUM

Home NPD Show link Help Norsk

Selecting Field ... 11 main categories

Synchronized 21.10.2013 - 03:58

Wellbore Licence BAA **Field** Discovery Company Seismic Facility TUF Pipeline Stratigraphy

- Attributes
- Page view
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... lists recorded members for the view. Selecting TROLL ...

Hide details Show details Map Feedback Download/Export ▶

Current activity status	PRO	<b>Download</b>
Discovery wellbore	31/2-	<b>CSV, XML,</b>
Discovery year	1979	<b>Excel</b>

**Picture**



**Discoveries included**

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	<a href="#">31/2-1 TROLL ØST</a>

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us from	Status to
Troll	1979 to 1995

The screenshot shows the NPD FactPages web application. At the top, there is a navigation bar with links for Home, NPD, Show link, Help, and Norsk. Below this is the main header with the text "FACTPAGES NORWEGIAN PETROLEUM" and a search bar containing "11 main categories". A secondary navigation bar lists various categories: Wellbore, Licence, BA, **Troll**, Discovery, Company, Seismic, Facility, TUF, Pipeline, and Stratigraphy. The main content area is divided into a left sidebar with a tree view of filters (Attributes, Page view, All, PDO approved, Producing, Shut down, Ordered by, Table view, Overview, Status, Operators, Owners, Licensees, Production, Reserves, Investments, Description, Geography) and a central list of oil fields. The "TROLL" field is selected, and its details are shown in a right-hand pane. The details pane includes a "Download/Export" button, a table with columns for "Current activity status" and "PRO:", and a "Discovery name" field containing "312-1 TROLL VEST". Below the details pane, there is a table with columns for "us from" and "Status to", showing data for "Troll" from "9 1905".

Shortcomings to the NPD FactPages:

- No query interface
- Arbitrary queries not possible, only predefined categories and views
- Poor identifiers
- Difficult information retrieval
- Integration “impossible”

NPD and NPD FactPages

Linked Open Data

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Tim Berners-Lee's 5 Linked Open Data stars

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Even better:

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- ★★ + machine-readable structured data (Excel)
- ★★★ + non-proprietary format (CSV, XML)
- ★★★★ + use W3C standards (URI, RDF) to identify and serve
- ★★★★★ + link to other data

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# Linked Open Data

Uniform Resource Identifier (URI)

- Schema for global identifiers

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## Uniform Resource Identifier (URI)

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  - Example: Core sample no. 3 of wellbore 1/6-A-7

`http://sws.ifi.uio.no/data/npd-v2/wellbore/903/core/3`

`http://factpages.npd.no/factpages/default.aspx?culture=en&nav1=wellbore&nav2=PageView|Development|With|WithCores&nav3=903`

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`http://sws.ifi.uio.no/data/npd-v2/wellbore/903/core/3`

- Using existing "web machinery"



# Linked Open Data

## Resource Description Framework (RDF)

- Simple, generic data model
  - It's all triples!

subject	predicate	object
<code>npd:wellbore/903</code>	<code>rdf:type</code>	<code>npdv:Wellbore</code>
<code>npd:wellbore/903</code>	<code>npdv:hasCoreSample</code>	<code>npd:wellbore/903/core/3</code>

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  - Easy to exchange
  - Easy to consume
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- No/One schema/schema independent, so (at a technical level):
  - Easy to extend
  - Easy to exchange
  - Easy to consume
  - Easy to query
- Use with “any” RDF tool
  - tools to browse, visualise, edit

# Linked Open Data

## SPARQL Protocol and RDF Query Language (SPARQL)

- RDF query language, similar to SQL

Not possible to answer with existing NPD FactPages

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  - receiving results
  - result format(s)
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  - using existing web infrastructure
- Safely expose data to querying over Internet
- Examples
  - ? Total production of oil and gas jan–jun 2010 for Statoil operated fields
  - ? Find things close to Svalbard
  - ? Ekofisk oil and gas production

Not possible to answer with existing NPD FactPages

# Linked Open Data

## Web Ontology Language (OWL)

- Language for formally defining vocabulary semantics
  - what the data *means*, not how to store it



# Linked Open Data

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  - Data is accessible to the “right people”
  - Easier to formulate queries

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- Domain-centric vocabulary
  - Data is accessible to the “right people”
  - Easier to formulate queries
- Sophisticated integration using relations between ontologies
- Formal semantics allows reasoning
  - infer new facts
  - check for inconsistencies
  - explain consequences and query answers

NPD and NPD FactPages

Linked Open Data

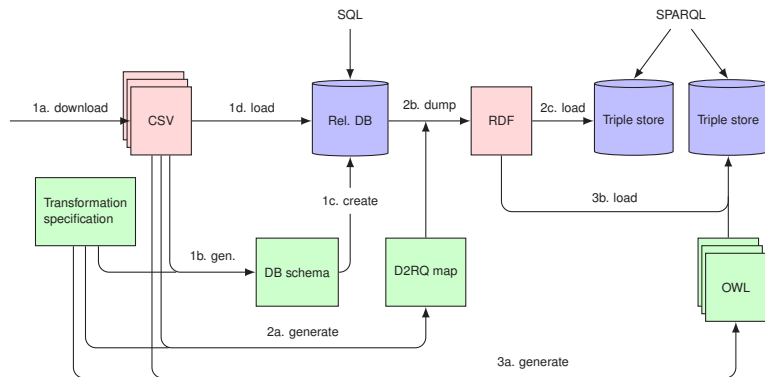
Converting NPD's FactPages to Semantic Web Data

Examples

Map Visualization

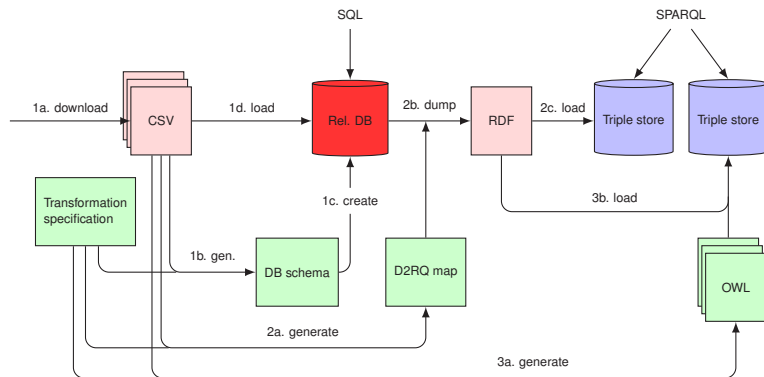
Query Formulation

# Conversion Process



# Conversion Process

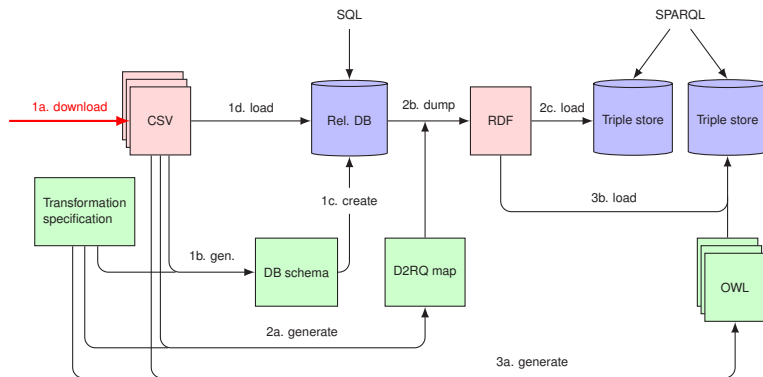
## 1. Create relational database representation



# Conversion Process

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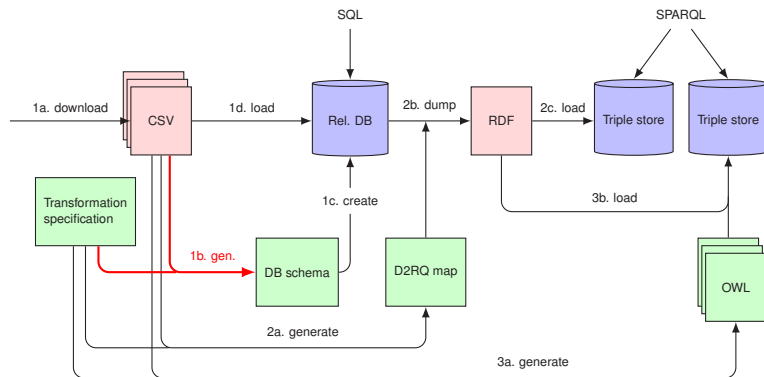
### a) Download CSV files from NPD FactPages website



# Conversion Process

## 1. Create relational database representation

b) Generate database schema—based on CSV files and transformation spec.



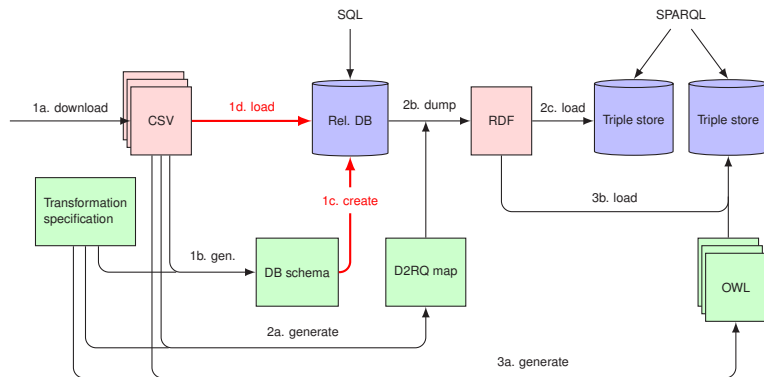


# Conversion Process

## 1. Create relational database representation

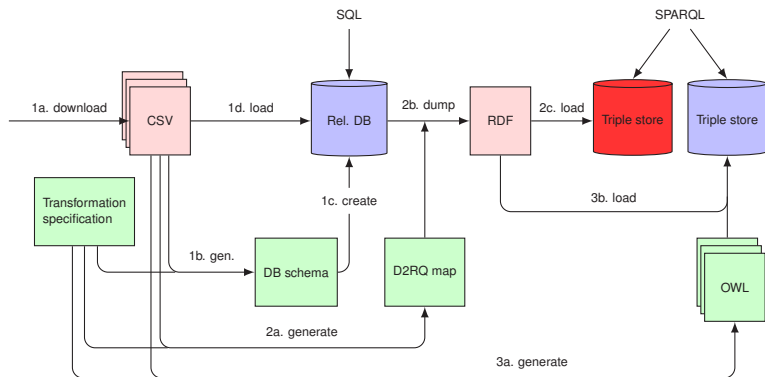
c) Create and

d) load the database



# Conversion Process

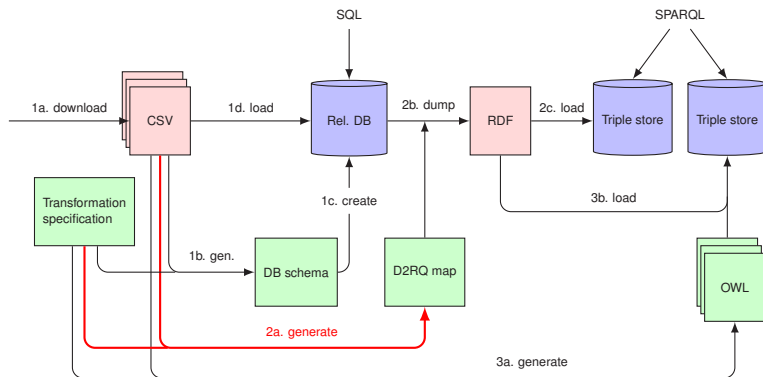
## 2. Create RDF/LOD representation



# Conversion Process

## 2. Create RDF/LOD representation

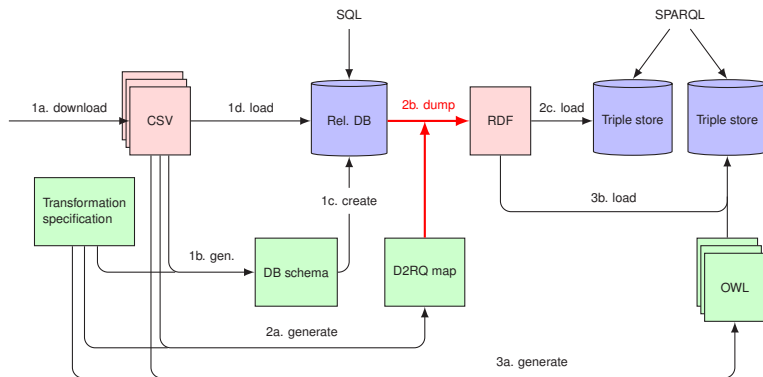
### a) Generate D2RQ map—based on transformation spec. and data



# Conversion Process

## 2. Create RDF/LOD representation

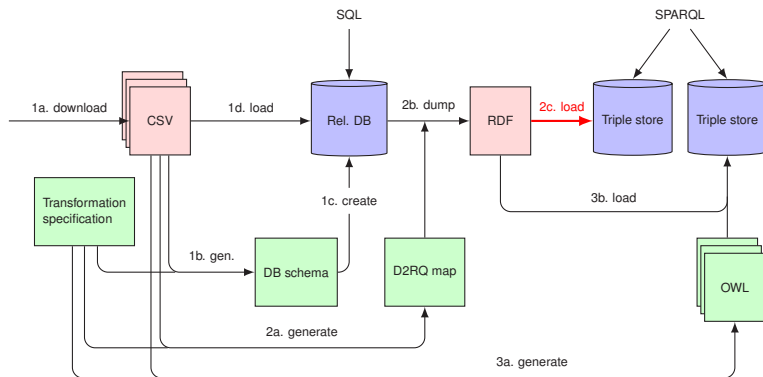
### b) Dump database to RDF using map



# Conversion Process

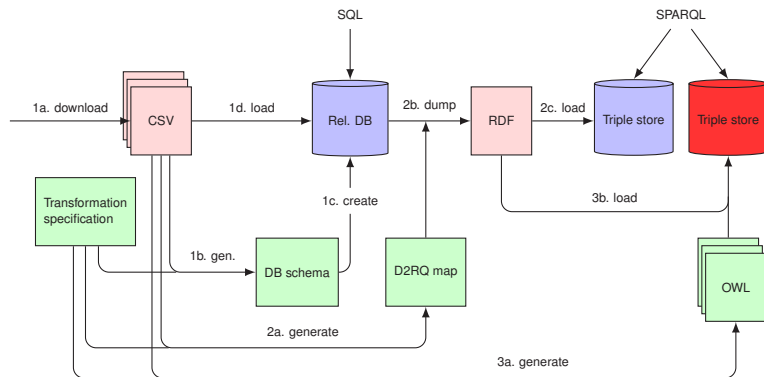
## 2. Create RDF/LOD representation

### c) and load into triple store



# Conversion Process

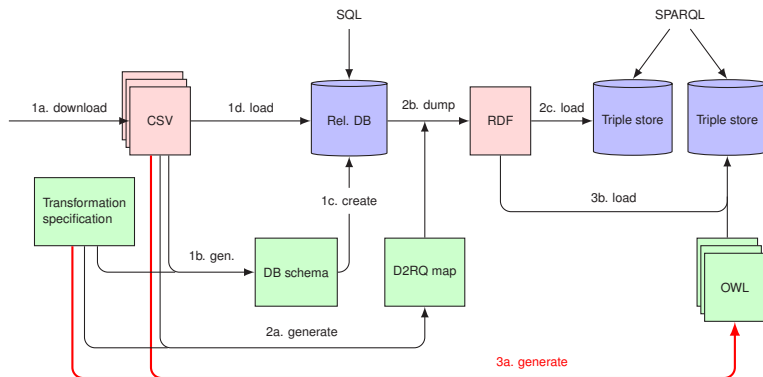
## 3. Create ontology representation



# Conversion Process

## 3. Create ontology representation

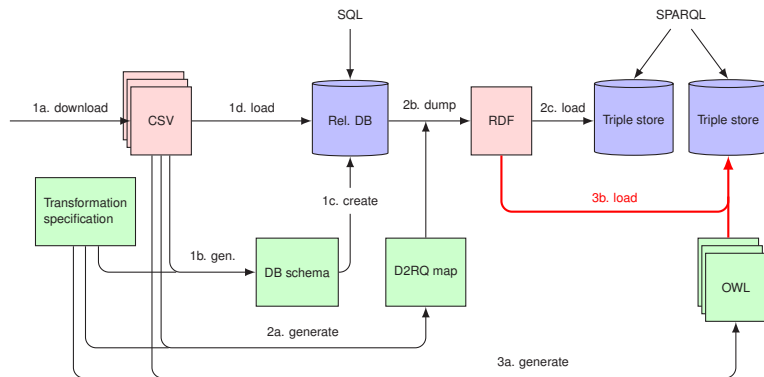
- a) Generate OWL ontology—based on transformation spec. and data—and extend manually



# Conversion Process

## 3. Create ontology representation

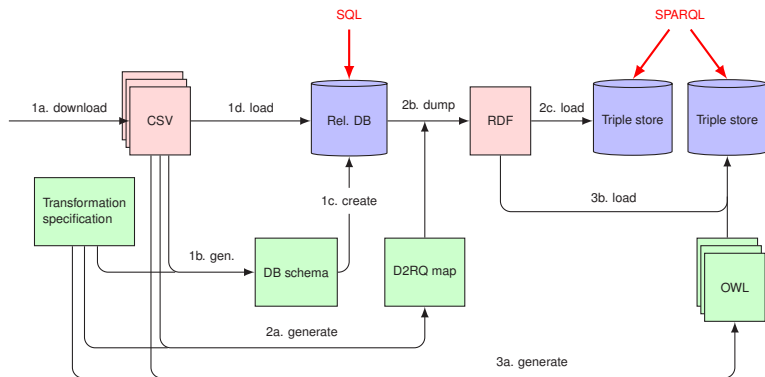
### b) Load RDF + OWL into triple store





# Conversion Process

We test the different representations in our query evaluation experiment



- Availability of data is better
  - Each thing has an identifier
  - Find information using identifier
- Easier to exchange and integrate data
- More data is available
  - Arbitrary SPARQL queries
  - New facts added by reasoning with semantics
- Semantics are more explicit
- All using standardised languages
  - application independent
  - general-purpose tools available

NPD and NPD FactPages

Linked Open Data

Converting NPD's FactPages to Semantic Web Data

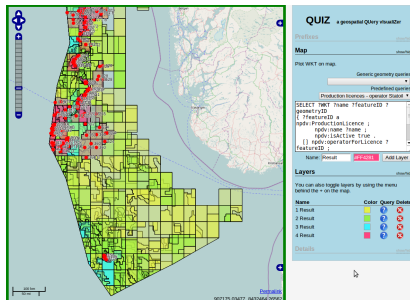
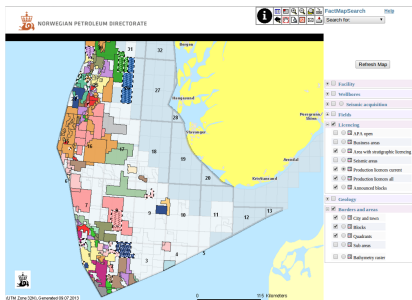
Examples

- Map Visualization

- Query Formulation

# Example: Map Visualization

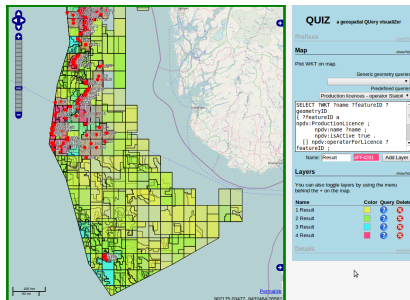
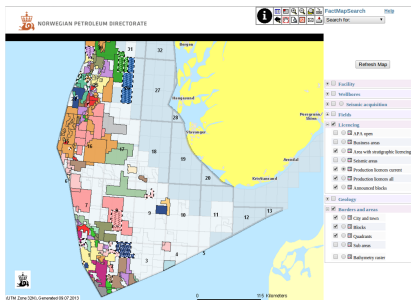
NPD FactMap vs. “our” SPARQL map visualiser.



- Official map app.

# Example: Map Visualization

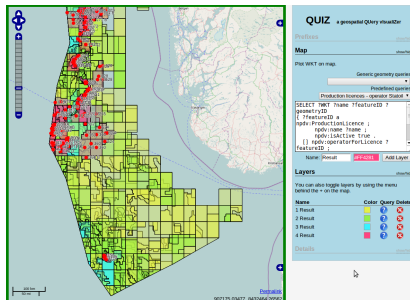
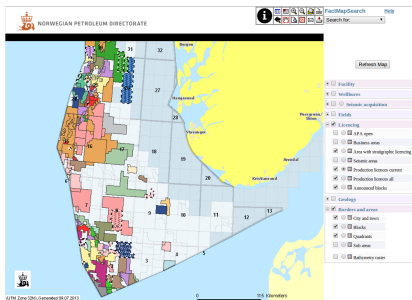
NPD FactMap vs. “our” SPARQL map visualiser.



- Official map app.
- Server side

# Example: Map Visualization

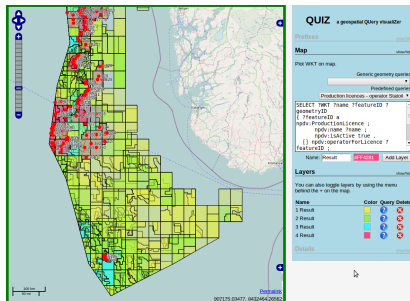
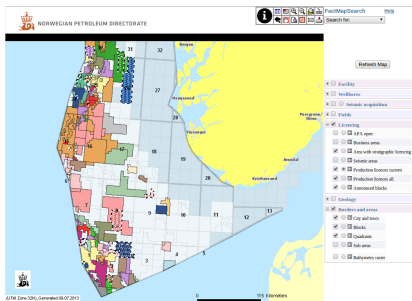
NPD FactMap vs. “our” SPARQL map visualiser.



- Official map app.
- Server side
- Predefined queries only

# Example: Map Visualization

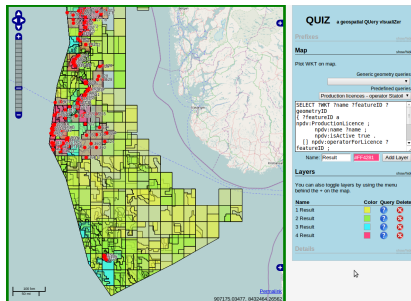
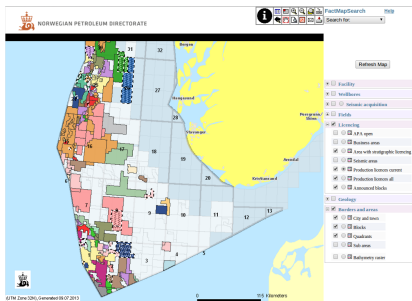
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- Official map app.
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- Predefined queries only
- Map results only

# Example: Map Visualization

NPD FactMap vs. “our” SPARQL map visualiser.



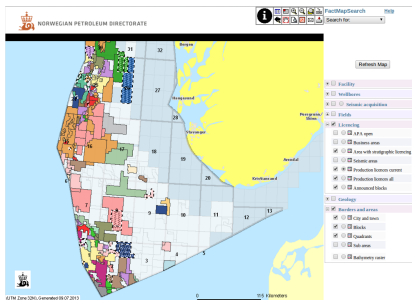
- Official map app.
- Server side
- Predefined queries only
- Map results only

- Generic map app

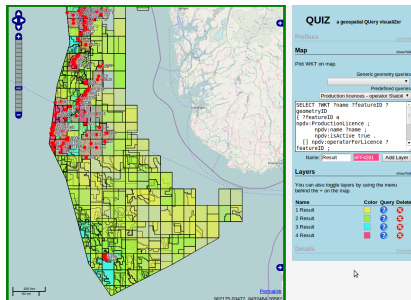


# Example: Map Visualization

NPD FactMap vs. “our” SPARQL map visualiser.



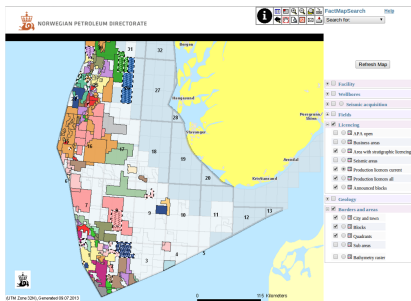
- Official map app.
- Server side
- Predefined queries only
- Map results only



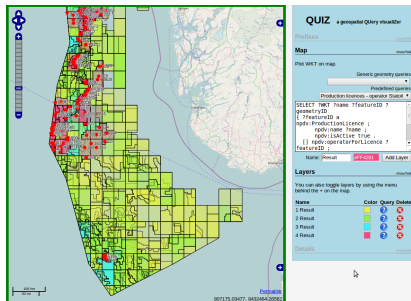
- Generic map app
- Client side, SPARQL based, open source

# Example: Map Visualization

NPD FactMap vs. “our” SPARQL map visualiser.



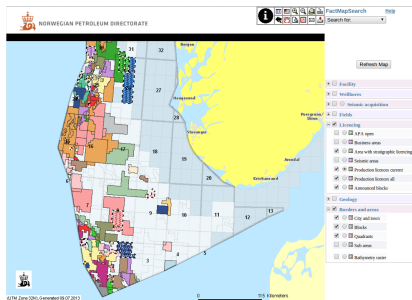
- Official map app.
- Server side
- Predefined queries only
- Map results only



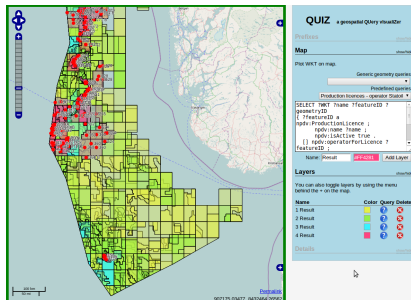
- Generic map app
- Client side, SPARQL based, open source
- Predefined generic ontology driven queries *and* any SPARQL query

# Example: Map Visualization

NPD FactMap vs. “our” SPARQL map visualiser.



- Official map app.
- Server side
- Predefined queries only
- Map results only



- Generic map app
- Client side, SPARQL based, open source
- Predefined generic ontology driven queries *and* any SPARQL query
- Results link to LOD

## Example: Visual Query Formulation

- We want data to be available to domain experts
- Most domain experts don't know query languages
- Developed query formulation tool
- Generic, ontology/data driven application
- Customized to dataset

## Example: Visual Query Formulation

Query: *Fields operated by Statoil Petroleum AS with gas producing facilities*

- `http://sws.ifi.uio.no/project/optique/qf/interface/`
- Field
- Company
  - Name: Statoil Petroleum ASA
- Facility
  - facility function: GAS PRODUCER
- Show SPARQL
- Run query
- Select SNØHVIT

For more information:

<http://sws.ifi.uio.no/project/npd-v2/>

Available for download:

- CSV
- SQL
- Mappings
- RDF dumps
- OWL ontologies
- SPARQL endpoint
- LOD front-end
- Queries