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App on every platform

The Norwegian Petroleum Facts app developed by the NPD and the Ministry of Petroleum and Energy for use on iPhones/iPads is now also available for Android and WindowsPhone mobiles.

Launched at Stavanger's ONS oil show this August, the app has already been downloaded by 5 500 users and is accessible for free in the App Store via *www.oilfacts.no*.

The new Android version is downloadable from the Play shop, while the one for WindowsPhone can be found at Marketplace.

Based on data from the NPD's online fact pages and maps, the app provides information about fields, production licences, companies, production and active exploration wells on the NCS.

Users can also access news stories from the NPD and the ministry.

The map function shows fields and active exploration wells, all linked to relevant background information. A search function is also provided.

In addition comes an analysis section which allows users to filter and sort data themselves. They can be stored as favourites to simplify later updating. Graphs can also be generated.

Users can chose between English and Norwegian versions. The app has been developed in collaboration with the Applaud company.

Screen images illustrating the app can be accessed at *http://youtu.be/Wd1vKa3u028. An introduction is also available at http://youtu.be/4sE1wXaC6bU.*

Oseberg tripled

Maths from Russian
Ghana shows the way
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Delving into the deep past

Geoscientists have flocked to Norway's Svalbard islands to help improve their understanding of Barents Sea geology – and to learn more about underground storage of carbon dioxide.

| Astri Sivertsen and Tone Johanne Sunde (photos)

Professors Alvar Braathen (left) and Snorre Olaussen at work on the plentiful sandstone exposed near Diabasodden.

A group of 50 people goes ashore on the Diabasodden headland in Svalbard's Sassen Fjord on a crystal-clear September day, together with four rifle-carrying guards.

Well wrapped up against the Arctic chill, they are taking a day-long excursion through the geological past from 215 to 65 million years ago. Their route will take them from the late Triassic to the late Jurassic at Deltaneset point.

Geologists may have a more intense relationship with rocks and the landscape than others. But they are not here today for the clear air and fine mountain formations.

This team of experienced geoscientists and reservoir engineers will be studying the clearly visible series of strata ascending the steep mountainsides.

Instead of having to investigate seismic data presented on a computer display, they can touch and feel the reservoir rocks up here at 78°N.

One professor chips out parts of a rock formation, while another collects loose stones in order to examine them later under a microscope.

Most of the big oil finds on the NCS lie in early and middle Jurassic rocks, says guide Snorre Olaussen, professor of Arctic petroleum geology at the University Centre in Svalbard (Unis).

"These are Norway's most important rocks," he explains. "The oil in Statfjord, Gullfaks and Troll in the North Sea has accumulated in sandstones from this period."

Identical

Sediments exposed in this part of Svalbard are also virtually identical to the sub-surface formations found beneath the Barents Sea to the south.

All the islands in the archipelago once lay beneath the sea, and much closer to the equator than they are today.

The excursion ends in the Konusdalen valley at the foot of Mount Janus, where shales deposited around 150 million years ago form the cap rock which can prevent oil seeping from reservoirs.

They could also stop carbon dioxide stored in sub-surface aquifers escaping back into the atmosphere.

The route from Diabasodden to Deltaneset has not been randomly chosen. Rocks exposed to the air here are also to be found several hundred metres below ground in the Adventdalen valley.

That location has been visited by the scientists the day before. The Northern Lights Observatory stood there until it was driven away by growing light pollution from Longyearbyen, the main Norwegian settlement in the islands.

This site is now occupied by the Xmas trees for five wells drilled by the carbon laboratory at Unis since 2009, along with two others close to Longyearbyen's airport.

These wells descend 403-907 metres into the ground, and the last of them was completed the week before the scientific expedition paid its call.

Seismic data have been acquired and interpreted, and a number of cores examined. Some of the latter studies are still under way. Geophones are also installed in several of the wells to record microseismic activity.

The rig used to drill the wells is one employed by Svalbard coal mining company Store Norske Spitsbergen Kulkompani AS to search for new deposits.

In addition to Store Norske and local builder Leonhard Nilsen & Sønner (LNS), several research institutes as well as oil companies Statoil, ConocoPhillips and Lundin are involved in the Longyearbyen carbon lab project.

Lundin is primarily interested in that part of the work which involves reservoir description, explains Hans Oddvar Augedal, chief geologist for this independent Swedish oil company.

"We can see reservoir rocks exposed to the light of day in Svalbard, and get far more information than by taking cores from the wells we drill in the Barents Sea."

He adds that a particularly interesting aspect of the project is that it has recovered continuous cores over a depth of almost 1 000 metres.

A core taken offshore will normally be 30-40 metres long, and derived from the reservoir itself. But the Svalbard cores include the permafrost layer and the source rock where oil may form.

"Continuous cores are extremely important for the NCS," says Augedal. "We're initiating a series of student dissertations based on samples you can never normally get hold of."

Expertise

He explains that Lundin became involved in the carbon lab project because it wanted to support expertise development and help to educate a new generation of scientists.

But its participation has also turned out to be considerably more useful than expected from a practical perspective. "We've secured very specific results in areas otherwise only studied from a theoretical perspective."

Olaussen reports that the wells cost a maximum of NOK 4 million each to drill. All three operators highlight this low bill as one of the big benefits of the Svalbard facility.

It can easily cost NOK 1 billion to drill a well in the North or Norwegian Seas, reports geological adviser Kåre Vagle at ConocoPhillips.

Adding that a shallow well in these waters usually sets a company back NOK 500 million, he notes

The shale underfoot near Mount Janus is a suitable cap rock for carbon storage – and a place to find fossil reptiles.

Geir Ove Titlestad has drilled wells for many years – but never before with a rifle on his back.

that "you can multiply the cost of drilling at Longyearbyen by 100.

"There's things you can do at the Svalbard lab which can't be done elsewhere, simply because it would carry far too high a price tag."

Carbon injection and storage are interesting to ConocoPhillips, but this is not just a matter of pumping the greenhouse gas down below ground.

It also has to be done in a secure manner, and the way the gas behaves in the sub-surface formation must be known. Vagle lists a number of questions which still need a full answer.

These include how the carbon dioxide will react with the rocks themselves, its effect on formation water, and how seabed fauna and flora might be affected if it leaks out.

Another issue arises if depleted oil and gas reservoirs with old wells and casing are used – can the steel and cement withstand the gas and, if so, in what concentrations?

"We must quite simply research these matters," Vagle observes. "The attractive feature of Longyearbyen is that we can create a laboratory in the open. You can drill wells to study the problems while pursuing carbon injection, and try out various methods."

Tests

Cores from the Adventdalen facility have now been sent to laboratories all over Norway, where they are being subjected to various chemical and physical tests.

Unis has not had access to carbon dioxide, forcing it to use water for its injection trials. Should further experiments be staged, Olaussen hopes to secure supplies of the pure gas.

That would allow its behaviour in the reservoir to be observed, he notes. "Although water and carbon dioxide have fairly similar densities, the chemical differences are pretty large."

The project has encountered several surprises along the way, including the fact that pressure in the intended storage formation proved to be more than 50 bar below the atmospheric level.

When the bit reached the lower sandstone layer, dating from the Triassic/Jurassic periods, the drillers both saw and heard air being sucked in when the valves were opened.

This phenomenon is not unusual in Arctic regions, Olaussen reports, and explains that it may be due to the effects of permafrost and land uplift.

Such underpressure has earlier been detected in some wells drilled in the Lopphavet bay off western Finnmark county in northern Norway, but was not as great there as on Svalbard.

More measurements and studies will be required to chart and understand the sub-surface pressure conditions, but the preliminary results after five years of research are encouraging.

"These areas could prove ideal for carbon storage," says Olaussen. "We can inject large volumes of gas, which liquefies under pressure."

Impermeable shales above the planned storage formation will be able to keep the gas in place. The 120-metre-thick layer of permafrost provides an additional seal.

What remains to be determined is the full extent of the structure, and how much carbon dioxide could be stored there.

No further wells are planned in Adventdalen. The rest of 2012 and next year will be devoted to processing the information acquired.

However, plans call for the wellheads to be covered so that they can be reused. First, however, the project must deal with an unexpected problem – natural gas was encountered in two wells.

In one case, in fact, the gas had to be flared to protect the downhole instruments in the well. The flame attracted attention, and became a front-page story in the local paper.

Nobody can yet say whether this represents a small gas pocket or a larger deposit. For the moment, the wells will be protected against Polar bears and snowmobiles until a decision on the next step is taken in 2013.

Clean-up candidate

The coal-fired power station at the Longyearbyen mining settlement in Norway's Svalbard islands is being seen as a possible location for carbon capture and storage (CCS).

Astri Sivertsen and Tone Johanne Sunde (photos)

Today's coal-fired power station in Longyearbyen could be replaced by a plant in Adventdalen equipped for CCS.

Longyearbyen is clearly a good place for carbon capture and storage, maintains Ragnhild Rønneberg. The Unis building is on the left.

A full-scale CCS plant – dubbed Norway's "moon landing" project – is already due to be built at the Mongstad refinery north of Bergen, following a decision by the Storting (parliament).

But the Ministry of Petroleum and Energy commissioned the state-owned Gassnova company in May 2011 to study opportunities for building other CCS facilities.

All known point carbon sources emitting more than 400 000 tonnes per year are under consideration, says press spokesperson Anne Margrete Blaker. These total some 10 large industrial plants.

Although it releases "only" 60 000 tonnes of the greenhouse gas annually, the 29-year-old Svalbard power station is also being looked at.

It generates heat and power for just over 2 000 residents in Longyearbyen and the nearby satellite stations, using locally-mined coal as fuel.

But diesel generators also have to be activated on particularly cold and windy days, reports general manager Marianne Aasen.

Today's power station fails to release enough carbon dioxide to justify a CCS plant, she adds. So any capture project would mean constructing a completely new generating facility.

"We're positive to installing CCS, but that would require the government to make the necessary funding available," Aasen emphasises.

The power station consumes about 25 000 tonnes of coal per year, transported by lorry from Mine 7 about 15 kilometres from the settlement.

Operational since 1975, this source produces 70 000 tonnes per year. Output not required for electricity generation is exported – primarily to German steel mills.

The Norwegian Climate and Pollution Agency (Klif) has ordered that the power station must install a treatment plant for sulphur, nitrogen oxide and particulates by September 2014.

Norway's Conservative Party proposed earlier this year that a new generating facility with CCS be built in Longyearbyen, which it believes could be ready as early as 2015.

That would be five years before plans call for the full-scale plant at Mongstad to become operational. But a proposal to invest in such a plant in Svalbard was voted down by the Storting.

The Norwegian Society of Graduate Technical and Scientific Professionals (Tekna) has also become an enthusiast for a CCS plant in Longyearbyen.

It calculates that a full-scale facility there would cost a fraction of the planned installation at Mongstad, and has written to the prime minister to press the case.

The University Centre in Svalbard (Unis) is refusing to take a position on when and whether a CCS plant for the power station could be built.

But it would contribute expertise built up through five years of work on carbon storage to a possible project, says Ragnhild Rønneberg, head of the Longyearbyen carbon lab.

"We have a lot of expertise in this area, which is lacking in many other places. There's also a potential storage site just five kilometres from the emission source.

"The short distance, combined with our know-how, means that this clearly represents a good place to build a CCS demonstration facility."

Seeking storage solutions

The Longyearbyen carbon lab has been established to develop and test technology for storing the greenhouse gas and to identify a suitable site for emissions from the local power station.

Norway's only coal-fired generating facility supplies the settlement of just over 2 000 people with electricity and heat, and emits 60 000 tonnes of carbon dioxide a year.

Established in 2007, the lab is a wholly owned subsidiary of the University Centre in Svalbard (Unis), which belongs in turn to the Ministry of Education and Research.

In addition to the Research Council of Norway, it is supported by ConocoPhillips, Statoil, Lundin, Store Norske Spitsbergen Kulkompani, Statkraft, Gassnova, LNS and Baker Hughes.

The NPD sits on the management committee for the lab, which collaborates extensively with universities in mainland Norway and a number of research institutes. It offers MSc and PhD courses.

Candidates other than Mongstad for potential CCS projects in Norway

- Alcoa's aluminium works in Mosjøen (and possibly in Finnmark)
- Gassco's gas processing plant at Kårstø
- Heidelberg Cement's mill in Kjøpsvik
- Hydro's aluminium plant at Sunndalsøra
- Industrikraft Møre's possible power station in Fræna
- Ineo's Noretyl petrochemical plant in Bamble
- Ironman – possible ironworks at Tjeldbergodden
- Naturkraft's gas-fired power station at Kårstø
- Statoil's Hammerfest LNG gas liquefaction plant (existing and possible trains)
- Yara's ammonia plant in Porsgrunn
- Bydrift Longyearbyen's possible new coal-fired power station

Source: Gassnova