

Please note, all questions submitted by users are unaltered and in their original form

User_name	Message	Response	Shell expert
Ryan	Question: Ryan: How much is Shell going to invest in CCS in the coming years?	Answer: Can't give you a specific number, I am afraid. Our current approach is to develop the capability to do CCS, responsibly, and with a view to driving its (currently high) costs down. So we are acting - through for example our involvement in Joint Industry Projects (I like CO2SINK for example). The big money for Shell and others would only be spent when we have (a) a good framework that makes it economically sensible to roll out CCS and (b) success with the early "learning by doing" demos.	John
Eduard	Question: Eduard: Hello. The U.K needs more gas storages as it becomes net importer of nat gas. Should it also look into CCS storages along wiht gas storages and how it can be facilitated? Regards, Eduard.	Answer: Eduard, thanks for joining us. In order for the UK to meet its aspiration for a ~50% CO2 reduction by 2050, CCS will play an important part. The UK is already taking initial steps with the ongoing CCS Competition and the formulation of the Committee on Climate Change to help define future CO2 budgets. Cheers, Bill	Bill
Julie	Question: JulieK: What is the consequence for the world of not doing CCS? Should we not focus on reducing emissions?	Answer: Good question, Julie. Shell's modelling shows that global take-up of CCS, across power generation and other industry sectors, could prevent more than 230Gt CO2 from entering the atmosphere between 2021 and 2050. This is the equivalent of reducing overall CO2 levels in the atmosphere by 20ppm. Securing an additional reduction of this magnitude from complimentary decarbonising measures such as renewables and nuclear, will be a Herculean task if rising demand for power is to be met. So we think it's an "And And" story with CCS playing an important role.	Marc

David	<p>Question: David : Technically, how far can the stuff be transported before it is buried. i.e if there is not a handy aquifer in the North Sea, could the CO2 be piped onshore to somewhere where there was one?</p>	<p>Answer: Hi thanks for the question Technically CO2 can be transported in pipeline over hundreds of kilometers to a suitable storage. Currently CO2 is transported for EOR in the States over approx 500 kilometers. The longer the distance the more expensive it will be. The IPPC quotes a benchmark of \$5/ton for 250 km and a range between 1-10 depending on distance and quantity. Longer distances will require booster pumps to keep the flow going. Another example is the Rotterdam climate initiative which is planned to transport from the European mainland into the North Sea where suitable aquifers are been identified</p>	Wilfried
Canada	<p>Question: Canada: Quick Question for John Barry: How much will CCS cost?</p>	<p>Answer: Widespread deployment of CCS will require a sustainable economic model - think of the hundreds of CCS projects that will be required. For my money, that will mean that CCS costs will have to come down to the level of CO2 prices (as set by trading schemes, for example)... and I guess if CCS is really important, as our scenarios suggest, then the marginal cost of CO2 abatement will be set by CCS and so you can also think of CO2 prices rising to meet the CCS costs. Hence our focus on (1) encouraging governments to put framework in place to "price" CO2, and (2) start demo'ing CCS to learn how to drive costs down.</p>	john
John	<p>Question: Andrew: So even though CCS 'looms large', Shell isn't putting up the 'big money' until a "good framework that makes it economically sensible" exists, is that right? But doesn't the Stern report say the investment we put in mitigating climate change now will save us money, and economic collapse later?</p>	<p>Answer: Hi Andrew. On your first point, I think we've all got to try to solve this together - its not reasonable to expect any single set of stakeholders (oil companies for example) to solve this on their own. What we bring are skills in CO2 management (from our EOR experience, for example) and project management... plus some money, yes... but we need to get governments acting to put a "level playing field" in place where emitted CO2 has a value and so players in the economy will take action, including CCS where justified, to reduce emissions. And of course, we'd love to see governments also joining in the funding of the early "R&D" style demonstrations, as we learn how to do CCS efficiently and to drive the costs down. As to the urgency... I agree with you.</p>	John

David	<p>Question: David : In terms of funding how much of Shell's Research budget is being put behind this project. Indeed, how much are the Govt's in Germany and Australia contributing to the pilot project? Could they generate funds for this important but costly exercise by a windfall tax on the oil companies' profits?</p>	<p>Answer: Hi David, a few queries in one question and I'll try to answer all of them. First, Shell considers CCS to be mostly beyond Research stage, rather we think that - whilst there is room for improvement and cost reduction - most elements of the technology are ready for Deployment and for 'learning by doing'. The costs of these projects may range from several tens of million dollars (for smaller scale and time bound CO2 injection projects) to several hundred million dollars (longer-term bigger scale CCS projects) to several billion dollars (for large scale projects). Governments (such as in Germany and Australia) are co-funding CCS projects through their technology demonstration or development funds or 'green' funds but the majority of the funding has so far been committed by industry, from this perspective the use of windfall taxes to fund CCS projects would not change the source of the current funding much.</p>	Tim
Eduard	<p>Question: Eduard: Hello again. What are Shells views on the IPCC target to carbon emissions by 50% by 2050. Seems your Blueprint scenario says it's not really achievable and will be flat or more to the level of 1990? Are we facing 3C of warming? Tx much</p>	<p>Answer: Hi Eduard, thanks for your question. The IPCC is the world's leading authority on climate change and we support and use their work. The difference between this target and our Blueprints scenarios is that the IPCC work starts from the perspective of asking 'what must we do'. In our Shell Energy Scenarios including Blueprints we start from where the world is now and explored a very aggressive rate of change in the world's energy system. Blueprints isn't the the maximum possible that can be achieved in CO2 terms, but it is aggressive change as the world seeks to manage CO2 emissions. It all comes down to how much political and social support there is.</p>	Monika
Ahoahoman	<p>Question: ahoahoman: Hi, how did shell make the costcurve of CSS? After 10 install, it becomes reasonable cost?</p>	<p>Answer: Hi thanks for the question. The curve shown is an indicative one to show the experience with a large number of technologies. Always the inital costs are high and with increasing use of the technologies smarter solutions are found and the cost come down. This "Boston experience curve" holds for all kinds of goods.</p>	
		<p>http://en.wikipedia.org/wiki/Experience_curve_effects shows more details</p>	

And we are confident that the same will happen with Carbon Capture transport and Storage

pagevanderlinde	Question:pagevanderlinde: Also, what is the time scale? According to the IPCC, we need to level out (and reduce) our carbon emissions by 2015 if we're going to have any effect on climate change. How long will it take to get CCS technology from the laboratory phase (if you will) into commercial use?	Answer: Good question. As you point out, there is indeed some urgency behind commercialising mitigation options such as CCS. If we can get the right regulatory frameworks in place and agree a funding package or mechanisms to help deliver the first large scale projects, then it's conceivable that CCS will be ready for commercial rollout by 2020, if not before. The underlying technologies are in use today but we need to demonstrate this at a commercial scale, especially in power generation.	marc
LisaNoble	Question:LisaNoble: Is there any CCS plans for the United States? And what about Cap and Trade? Which is the more likely plan for the U.S.?	Answer: Welcome LisaNoble. We are working with a number of govt/industry/academic partnerships to study CCS in the USA. We are also looking at opportunities for CCS demonstration projects in the USA, particularly on the West Coast and Gulf Coast. As for Cap and Trade, we very much support this as a framework for reducing emissions. We would like to see CCS recognized as one way of reducing CO2 emissions under Cap and Trade.	John K
pagevanderlinde	Question:pagevanderlinde: How much additional energy will it take to carry out CCS for each power plant? Also, what additional resources are needed for the process? Climate change is threatening water supplies around the world (I should know, I live in the desert). Wouldn't CCS require additional water per power plant?	Answer: Thanks for the question. When considering efficiencies of power plants with & without CCS the efficiency of power generation and CO ₂ capture must be considered together. The efficiency of a power plant without CCS is typically between 40 and 50%, while a CCS power plants efficiency would likely have a 10% efficiency penalty. Via the process of learning by doing we expect this penalty will reduce. Power plants are based on large steam cycles - steam is used to drive turbines to generate electricity, wet steam leaving the turbine is then recycled for reuse. Capture plants require heat and power to drive the	theo

process (1 to drive the regenerator to remove CO2 from the solvent, which earlier was picked up from the fluegas and 2 to compress CO2 to the required storage pressure). Steam and electricity is used for this purpose and taken from the main power plant, after its use - as with the main power plant - steam/water will be recycled.

Belinda	Question:Belinda : Do you think that the 'holy grail' of CO2 mineralisation is overkill- turning a gas into a rock (a rather energy inefficient process itself)? Do you think that the public can become comfortable with geological CCS? What can we do better to relay fears of CO2 'bubbling back' to surface (apart from changing the scale of our diagrams!)?	Answer: I do not think that mineralisation is the 'holy grail'; it is one of an set of technologies that needs to be pursued. As far as public acceptance for CCS is concerned there is definitvely a need for more information on how CCS actually works. There is lots information available in an IPCC report on CCS which also discusses risks and comes to the conclusion that they are manageable over the long-term. However, we need to get this message more widely communicated.	Wolfgang
alanb	Question:alanb: Is there not some minimum level of cost for CSS, given that an unavoidable amount of energy is required to inject the CO2 into the underground reservoir.	Answer: Hi, thanks for your question. You are right on this; there will be energy required to do CCS, to capture the CO2 (in most cases), transport it and inject it into an aquifer. This is associated with costs of which the majority is usually in the capture. If there are cheaper alternatives to reduce CO2 emissions you will normally start with that, but in cases where CCS will be the only answer the costs will have to be carried. I hope this clarifies.	tim
Ryan	Question:Ryan: Is Shell reinjecting CO2 to enhance oil recovery too?	Answer: Hi Ryan, good question. Getting more from existing fields will be a key part of meeting the world's growing demand for energy. Shell is actively looking for opportunities to unlock the difficult barrels and improve production from each field, and is using several technologies including EOR. Miscible gas, including CO2 EOR, is proven and widely applied, the challenge is often matching an affordable CO2 source with a viable candidate field. Shell's approach is to build upon our experience in designing and operating the largest CO2 EOR project in the world (Permian Basin - McElmo Dome/Denver Unit) and leveraging integrated value chain technologies (e.g. gas separation, subsurface, wells, smart surveillance).	Edward

AlexandraHakal	Question: AlexandraHakala: Good morning from Pittsburgh (PA, USA). I have a couple of questions related to the geochemistry involved with carbon capture and storage: How is the fate of injected fluids monitored in overlying geologic confining units? Is Shell investigating the potential geochemical reactions that may occur in the event of fluid leakage from the primary storage aquifer?	Answer: Hi Alexandra -- Good question...We design our projects to include an understanding of the reservoir, seal, and fluid geochemistry, and we model the expected reactions using data acquired in appraisal wells. Monitoring of the injected fluids depends strongly on the project itself, with many different techniques available that must be adapted to the details of the subsurface. These techniques may take the form of remote sensing methods using acoustic or electrical methods, or they may use a more direct measurement using monitor wells designed specifically for that purpose.	Rich
bcgovt	Question:bcgovt: CCS is much more applicable at a gas plant, as the capture cost is minimal as the CO2 is already captured, so why focus elsewhere for demonstration projects?	Answer: If this is the BC government, Hi and I wish I was in beautiful BC! You are quite right that capture from a gas plant, where e.g. methane contaminated with CO2 is processed, can be cheap - in effect, the seller has to remove the CO2 anyway, for sales purposes, so the incremental cost of transport and storage is all we need worry about. There are some other relatively cheap sources, too - like capture from Steam Methane Reformers in refineries. And while many of the early CCS projects will thus rely on CO2 from gas treatment (e.g. In-Salah in Algeria, Sleipner in Norway) or Refineries (we are capturing CO2 in Holland from the refinery) we also need to demonstrate other capture technologies e.g. capture from power plants - which will have to be a big part of the longer term CCS deployment. I guess what I am saying is we need a diversity of early learning projects	Theo

jw8765 Here is a link to a study done in the US
http://sequestration.mit.edu/pdf/EST_web_article.pdf
This has some answers to cost questions for those who are interested in at least one perspective.

Sarah Question: Sarah Hughes: What are the biggest risks associated with CCS besides not doing it? Answer: The biggest risk associated with CCS is that it may fail the test of public acceptance and leave a big hole in our efforts to reduce global emissions. Stories about CO2 leaking catastrophically and being hazardous to public health need to be laid to rest. Contrary to popular conception CO2 is stored deep beneath the surface – typically from 1km to 3km – in similar reservoirs to those where we know natural gas has been stored for millions of years. CCS certainly needs to be discussed openly and transparently – and I hope today's webcast is a step in this direction. Marc

windie Question: windie: What is the expected energy efficiency of CCS? Answer: Windie Thanks for the question wilfried

When compared with the normal practice of putting CO2 in the air diluted getting CO2 pure at high pressure "in your hand" will require additional energy. The efficiency of a power plant without CCS is typically between 40 and 50%, while a CCS power plants efficiency would likely have a 10% efficiency penalty with current capture technologies. Research is going on to increase the efficiency of CO2 capture

<http://www.co2captureandstorage.info/>

will give an idea on the ongoing activities

Sarah Hughes Question: Sarah Hughes: What other technologies to reduce CO2 in the atmosphere are being investigated? Answer: Sarah, thanks for joining us. If we look to mimic nature in reducing CO2, two of the developing technologies would be CO2 mineralisation and capture with biomass. Bill

In terms of thermodynamics, the CO2 molecule is in a very low energy state. By converting it to a carbonate mineral it goes to an even lower energy state. This process is being investigated at a number

of institutions.

Biomass has the ability to convert very low concentrations of CO₂ in to plant mass. This process extracts CO₂ from the atmosphere. We see developments with both land based biomass as well as water based algae.

Mark Inchley	Question: Mark Inchley: Is CCS being handled by a dedicated group within Shell, or is on the worklists of the various specialist groups, like gasification and gas treating?	Answer: Thanks for your question Mark. Overall management of CCS – driving the deployment of the technology through CCS projects and all that it takes – is being handled by a dedicated group within Shell, but support is provided by professionals in our Businesses, including sub-surface, gasification, gas treating, facilities (for capture) etc. Hope this clarifies.	Tim
Ryan	Question: Ryan: Is Shell lobbying for any Copenhagen 2009 agreement to include inducements for investment in CCS?	Answer: Global deployment of CCS requires an enabling policy framework. Currently we are supporting the inclusion of CCS into the Clean Development Mechanism of the Kyoto Protocol. Furthermore we are hoping that the Copenhagen process delivers a mechanism that could incentivise CCS post-2012 when the Kyoto Protocol is replaced with a new international climate change policy architecture.	Wolfgang
Scramble	Question: Scramble: Shell have been setting the case out very clearly in Brussels for incentivising the EU's Flagship Programme for CCS. What are the large-scale opportunities for projects which you envisage taking advantage of via the Programme once suitable funding is plan place?	Answer: For our own part, we are evaluating opportunities in The Netherlands and Norway – which are at this stage not firm, I have to say they tend to be complex projects to put together as they involve a long value chain from source to sink and many stakeholders, so chance of success is usually less than 100%. But I would expect others e.g. European power producers to be very interested in developing projects for the flagship programme – especially if they are coal based generators with relatively higher CO ₂ intensity. We are happy to engage with these folks, indeed we regularly do, to see if Shell skills (specifically in geological storage and in provision of coal gasification technology) can sensibly be deployed in their projects – provided of course we can find a commercially sensible way of co-operating.	John

Richard Folland	Question: Richard Folland: What do you think of the CCS draft legislative framework that the EU is currently trying to push through? More generally, are the Europeans doing enough to promote CCS as a commercially deployable technology?	Answer: Europe is definitively taking a step in the right direction. What is important now is to accelerate the process for early deployment of CCS.	Wolfgang
3P	Question: 3P : So CCS does not qualify for EU ETS or KP CDM credits?	Answer: That is correct	Wolfgang
SteveC	Question: SteveC: Could you provide a little more detail on the co2 capture project from the refinery in Holland? Is it from the FCC unit or from the production of hydrogen?	Answer: Steve, in Pernis we operate a gasifier for liquid residue products. From the syngas product we produce hydrogen for our processes and we produce electric power. This gasifier also produces pure CO2. We currently supply a part of that CO2 to greenhouses where it replaces the firing of natural gas. The CO2 to be stored will also come from this gasifier	wilfried
Anthesis	Question: Anthesis: It looks like a fairy tale with some reality facts missing. There are costs for CCS but where the profits will come from? Who will pay for CCS and who will benefit from it? What are you planning to do with the stored CO2?	Answer: Thanks for your question. You are right that this is not a fairy tale and the costs of CCS will have to be carried by the world. Where alternatives to reduce GHG emissions would be cheaper or more effective there's where you would start. To reduce global acombe a sufficiently however Shell scenario's indicate CCS will be necessary and this will have to be paid for. The profits will not be in financial returns, rather in reduction of CO2 in the atmosphere and hence reduced effects of climate change. The stored CO2 is planned to be stored indefinitely, in the pores of deep aquifers. I hope this clarifies.	Tim
Shelley C	Question: Shelley C: What traction are Shell getting from governments to enter into a policy debate and potential subsidies for CCS?	Answer: We are working with governments, industry partners, research institution, and international agencies to develop a robust policy framework for the commercial deployment of CCS	Wolfgang
ahoahoman	Question: ahoahoman: Wells go deeper, Injection cost will be higher. Do you determine the proper depth for CSS?	Answer: Hi...thanks for the question. Yes, there are many different cost drivers for a CCS project, including the cost of capture, transportation, and injection into a secure subsurface container. Indeed, well depth is usually a smaller percentage of the expected cost of a typical CCS project. Regarding the specific question about well depth, there are many different technical considerations that go into the well	Rich

depth. Our primary concern is long-term, safe containment, but of course adequate capacity is also a primary consideration.

David	Question:David : Once it is buried, we will doubtless hear scare stories about leaks/escapes/ possible environmental damage. How will you go about persuading communities that this is a no-risk solution. Maybe (as with nuclear waste) the answer is to pay the communities to take it.	Answer: David – you have hit on a key variable in this whole story. Public support will be critical, especially for on-land storage, which will be the cheaper way to do CCS since offshore projects are always more expensive. I think we need to ensure that respected independent experts are involved – why should the public believe an “interested” party? SO let’s get the truth out, namely that CO2 storage should be completely safe, if done responsibly in the right kind of geological formation at sufficient depth. Let’s allow open debate, independent verification. And let’s show people it works – hence the focus of some of the early demos. We can build on decades of experience with CO2 injectio in Texas, and with natural gas storage underground in e.g. Netherlands and Germany. I am reluctant to follow the nuclear waste route too closely – I would be reluctant to drink a glass of water with low level radioactive waste in it, while I regularly, voluntarily and with great pleasure drink water with CO2 in it (champagne!)	john
David	Question:David : Hang on. ‘the risks are manageable in the long-term’. Does that mean then that Shell think the short-term risks are NOT ‘manageable’? Yikes..	Answer: Not at all. Doing CCS responsibly spans the entire operation. Capturing, transporting, injecting and monitoring CO2 underground are all manageable. For the past 30 years, the oil industry has been transporting and re-injecting CO2 into depleted oil and gas reservoirs in the United States. CCS certainly brings with it some new challenges but nothing that cannot be overcome if responsibly done.	Marc
Ed	Question:Ed: What technologies do you think are viable for post-combustion carbon capture.	Answer: Hi Ed. Thanks for your question. Viability will depend on the level CO2 trading values will arrive at. At current levels unique circumstances are required. E.g. today post combustion could work in conjunction with Enhanced Oil Recovery. For storage we have to walk the cost curve and we anticipate costs will drop via the process of learning	Theo

by doing. Technologies (e.g. amines based) are available today but further innovation is required to make these cost effective. At present there are no clear winners for capture. Pre-combustion or oxyfuel could yet prove to be important contributions as well.

John Van Ham	Question: John Van Ham : Regarding the cost-curve above. The Boston Consulting Group's Experience Curve may in fact be a U-shaped model for how cost drive down over time. However, other researchers state prior to the Experience Curve there is often a period of cost increases (during the early stages of tech development). So, picking the point a technology is on a cost curve is very difficult. According to your slide CCS is on the downward trajectory of the curve. How do you know that we aren't still on the U-shaped side of the curve?	Answer: Thanks for your question. In Shell we believe that CCS is in a stage of "Deployment" rather than Research; we think that many of the components of the value chain (capture/separation, transport, compression, injection, monitoring) have been proven in the field over the past decades but now need to be scaled up (capture in particular), further improved, and deployed on a wide-scale to reduce costs. It is what we are working on through developing a global portfolio of CCS projects and it's this drives us to believe we are on the downward trajectory of the cost curve. We will have to keep in mind however the current significant increase in costs in the O&G industry in general; this may obscure relative cost reductions achieved in CCS.	tim
NRCat	Question: NRCat: If there was "a good framework that makes it economically sensible to roll out CCS" would uncertainty over long term liability prevent Shell from being among the first movers for commercial-scale CCS projects?	Answer: Just to make sure, for CCS we are talking about storage for hundreds of years. Long-term liability should be transferred to the public domain as only states have the longevity to manage storage sites effectively over the involved time frames.	Wolfgang
pagevanderlinde	Question: pagevanderlinde: I have a question about the purity of captured CO2. I'm assuming that your proposal will involve scrubbing of the captured CO2, correct? (getting rid of trace heavy metals, NOx, SO2, etc.)	Answer: That is correct. Processes exist today that can provide the CO2 quality required for sequestration.	Theo
vanderres	Question: vanderres: Can you elaborate a bit more as to what Shell wants to learn from the demonstration projects. What do you want to demonstrate?	Answer: Thanks for the question. We are really aiming to grow our own understanding of the processes, to show regulators and the public that it works and is safe, and to seek ways of driving costs down. This last one may be indeed the most important deliverable, as right now CCS costs are in most cases well above current CO2 prices. Experience with Flue Gas Desulphurisation in the USA showed that costs came down by a huge factor (not sure, but I think it was down by two thirds) simply through "practice" – doing a lot. John	john

Ryan	Question: Ryan: Will the stored CO2 have any value as a fuel in its own right well into the future?	Answer: Thanks for the question. CO2 is not combustible as it is a by-product of combustion, so therefore is not considered a fuel in its own right. However, depending on the design of a storage project, there could be the possibility of recovering the CO2 for future commercial use (food processing, enhanced oil recovery, etc.) Hydrocarbon natural gas has been stored in and retrieved from depleted gas fields in The Netherlands for more than 15 years.	Edward
lacombe	Question: lacombe: Does Shell have any partnership with universities to develop such models and projects? Which ones? What are the possibilities open by Shell to receive academic contributions in such matter, especially from my institution (PUC-Rio) in Brazil?	Answer: We have a multitude of academic partnerships around the world. As far as Brazil in concerned I need to come back to you.	Wolfgang
jw8765	Question:jw8765: How many metric tons of CO2 is Shell going to be involved with potentially on an annual basis above the amount that it already utilizes in its oil recovery programs or will the oil recovery projects be the total extent to which Shell's involvement will be?	Answer: I interpret your question as; how much CO2 will Shell store (over time) in depleted fields or aquifers, i.e. not used for Enhanced Oil Recovery. Well, the majority of CO2 will be stored in aquifers since the application of CO2 for EOR globally is very limited compared to what the world will have to store. I hope this answers your question.	tim
jw8765	Question:jw8765: Is it possible to freeze CO2 for the purposes of transporting? Also I would like to know what goes into the ships that carry LNG to the US on their return back to the point of supply? Are they empty?	Answer: You can freeze CO2 for shipping - think of dry ice - but actually its easier to ship liquids so for CO2 shipping its usually both cooled and pressurised, under which conditions it becomes liquid. Unfortunately for us, LNG tankers are unpressurised, so we can't use them for CO2 transport (it would be solid, and not pumpable...) However there are dedicated ships for LG transport and they typically can be adapted to ship CO2 . I've seen some Norwegian studies of perhaps shipping CO2 to offshore fields for enhanced oil recovery, not yet implemented as far as I know.	john
jbrady4	Question:jbrady4: Is there any private energy company consortiums established that could add critical mass to the pursuit?	Answer: Yes indeed, private energy company consortiums are already making an impact. Shell and Stanwell corporation are cooperating in Australia to combine capabilities to deliver lower emission electricity from coal. Shell, with reservoir management insights, has joined forces with	bill

Mitsubishi Heavy Industries and their CO2 solvent expertise to create an alliance for CO2 management in the Middle East. In Australia we have joined forces with a number of industry and academic partners in the Otway Basin Pilot Project. In Germany we are also working with industry and academic partners to inject CO2 near Ketzin. In addition to joint projects we also participate in cross industry groups like USCAP to help regulators in formulating policy.

jw8765	Question:jw8765: Has there been any attempts to deal with Carbon capture through nanotechnology?	Answer: Thanks for the question. We and the industry are looking in different technologies for capture, in pre, postcombustion and oxyfuel technologies. Some are more mature. Others are more at the discovery stage, like nanotechnology. Developments in different area's, e.g. in production, scale up and material properties are needed for discovery technologies	wilfried
Eduard	Question: Eduard: Thanks. So what is your projection of the temperature rise? IPCC says if the world doesn't meet the target it will be 3C up. So you say that realistically the target wont' be meet, meaning the temperature will rise. How much?	Answer: We are not climate scientists, but do take the predictions of the IPCC, the world's foremost authority on climate change science seriously serious. As a matter of fact we are one the first companies who acknowledged the risks of climate change - please see our website on climate change	Wolfgang
pagevanderlinde	Question:pagevanderlinde: Have you fully evaluated the potential impact of CCS on various ecosystems? What are the potential impacts, generally speaking? of geological storage would be comparable to the risks of current activities such as natural gas storage, EOR and deep underground disposal of acid gas.	Answer: This is an important question. Learning about ecosystem impacts by careful monitoring of injected CO2 is an important objective of early small scale studies and demonstration projects. So we will learn more by doing. Generally speaking, we have looked at analogues such as EOR and natural gas storage and conclude based on this that the risks to ecosystems will be very small if CCS sites are properly designed and operated. Examples of ecosystem risk include pipeline leaks as well as subsurface impact to drinking water. The IPCC supports this as well and provides a much more nuanced answer. From the IPCC "With appropriate site selection based on available subsurface information, a monitoring	John K

programme to detect problems, a regulatory system and the appropriate use of remediation methods to stop or control CO2 releases if they arise, the local health, safety and environment risks

http://ipcc.cac.es/pdf/special-reports/srccs/srccs_summaryforpolicymakers.pdf

Canada	Question:Canada: In absence of a global framework that includes all large and emerging economies, could strong unilateral action from the US (harmonized with existing initiatives in Europe, others) evolve into the global 'blueprint' scenario you envisage?	Answer: This is certainly one path forward. Shell supports the efforts of legislators and policy leaders in the US to craft climate change legislation. The US Senate recently debated a unilateral climate change bill (Lieberman Warner). Nearly all members of the Senate - regardless of party - acknowledged that global warming is a problem that must be addressed, despite differences of opinion as to the tough decisions needed to do it. We regard the Senate's deliberations as an important step forward and urge Congress to continue efforts to develop cap-and-trade climate protection legislation that will garner widespread bipartisan support.	John K
pagevanderlinde	Question:pagevanderlinde: "Stories about CO2 leaking catastrophically and being hazardous to public health need to be laid to rest..." -- can you address those concerns in a little more detail? I realize the CO2 will be buried deeply, but can you talk more about *why* it isn't dangerous?	Answer: Hi ... I appreciate the question as it is foremost on many peoples minds. It's important to remember that CO2 is not combustible, and concentrations much higher than normal must be reached before they pose any adverse risks to human health. Furthermore, the CO2 is stored underground within the tiny pore space of the rocks -- not in a large pressurised single "chamber" -- so in this situation it is not possible to release very large quantities of CO2 in a catastrophic manner.	Rich
james	Question:james: are there any initial results from the feasibility studies?	Answer: Yes, we have extracted many learnings and also confirmations of our models from the demo projects that Shell is involved in. Good insights have been gained in costs, CO2 injection, capture facilities designs, etc. All learnings are being used in subsequent projects. I hope this helps.	tim

3P	Question: 3P: Roughly how much CO2 can be captured and stored, in the demo projects you mentioned for example, vs. at a natural gas plant or oil refinery? Cost comparison?	<p>Answer: Capacity is not the only issue we consider. Naturally volume is of importance as we aim to deploy at a large scale. But smaller demo's are also valuable whether at refineries or power plants to test particular technologies as well as build up public acceptance using smaller volumes.</p> <p>Cost is the issue, first round of projects will be extremely expensive, which is why transition funding is required for these demo's. In the longer term we envisage cap and trade markets, with a meaningful carbon price, sustaining and spreading CCS worldwide.</p>	theo
Scramble	Question: Scramble: How many people is Shell employing on CCS now?	Answer: We currently have approaching 100 staff on CCS issues - if we include project developers, geologists, engineers looking at capture etc. I confidently expect this number to grow! John	john
Anthesis	Question: Anthesis: Who is the world that will pay? And how? Tax on gas?	Answer: We look at market-based policy mechanism, in particular cap-and-trade to send the necessary price signal so that companies will undertake CCS.	Wolfgang
Canada	Question: Canada: Can geological sequestration be done at a giga-scale in perpetuity?	Answer: Hi, thanks for your question. Over time, based on the learnings of many demo projects and given sufficient size of underground saline aquifers these CCS projects can be scaled up significantly. There is in principle no limitation, provided there's sufficient storage space; we could see multiple projects of tens of millions of tonnes per annum injection. I hope this clarifies.	tim
Canada	Question: Canada: How can we avoid a 'reurgence of coal' (combustion) as a potential 'unintended consequence' prior to an enabling global policy framewok for CCS?	Answer: With the rapid increase in public awareness and the growth of regulations in many regions, we would expect to see coal based developments accounting for the onset of CO2 emission regulations in their designs and investment economics.	bill
	<p>John,</p> <p>There is often discussion in various external communities about how technology will solve Global Warming. Personally, I'm not convinced. To me the Global Warming issue is the largest POLITICAL challenge mankind has</p>	<p>Answer: I agree that this is not just a technology issue. I think Shell's efforts to help "the world" understand what needs to be done are generally appreciated, think of the planning scenarios we make and share, for example. But we do bring some unique things on the technology front, both sub-surface and</p>	john

ever faced.

Shell certainly spends a lot of time on the technology aspects. Bearing in mind the possible future revenue from CCS - are we doing enough to influence Government

surface. So its a balance, yes. Thanks for the question.

jw8765	Question:jw8765: What about CO2 H2 = Methanol and how much of a possiblity does Shell see this?	Answer: We are studying different technologies. John's slide shows the precombustion gasification and the reformer technology to synthesis gas and CO2. This synthesis gas can be the straightforward feedstock for a methanol plan or it can be "shifted" to Hydrogen . Both processes will give additional CO2 to store. In principle you can react CO2 with Hydrogen again to methanol but on fossil fuel basis the straightforward path is more efficient. In principle hydrogen could be made from renewable sources and then this CO2 to methanol route is one of the options to have methanol as a liquid energy carrier as an alternative to hydrogen.	wilfried
Canada	Thanks to the Shell team for your excellent dialogue. Quick plug for Canada: Federal proposed legislation has several drivers for CCS technology (additional requirements on new facilities, CCS expenditure qualify for regulatory 'credit' obligations, others..)		
jw8765	Question:jw8765: How much manpower does Shell plan on using to address the CCS issue and are there any current hiring in this feild and waht are the qulifications of those that would be hired if Shell intends to hire some?	Answer: So we are approaching 100 staff on CCS today, and I expect this to grow significantly as some real CCS projects begin to move into implementation. 'd hate to guess what that (larger) number might be, but I'd offer the thought that in the longer term this needs to become normal business for our staff. Just as they think barrels, dollars, safety today, they must increasingly think "tonnes of CO2" tomorrow. Its a big culture change for us, and for the rest of the world.	john
pagevanderlinde	Question:pagevanderlinde: It seems like there are a staggering number of variables involved in successfully implementing CCS. You've talked about economic issues, problems to be overcome regarding government support, the difficulty of determining liability and legal issues regarding storage, etc. You also said that you expect to successfully launch CCS on a commercial scale within the	Answer: Hi, thanks for your question. Indeed the task is significant - you spelled it all out - but as Shell's Energy Scenarios and many international panels indicate we will have to make CCS work to reduce the CO2 concentration to acceptable levels. Fortunately the technology exists, CCS can be done today, and there are encouraging developments on most of the	tim

next 12 years or so. Seems unlikely to me... you really do think you can overcome all of those obstacles?

Andrew

Question: Andrew: Surprising! "Capturing, transporting, injecting and monitoring CO2 underground are all manageable. For the past 30 years, the oil industry has been transporting and re-injecting CO2 into depleted oil and gas reservoirs in the United States."

other enablers. I believe we can and will get it to work in time.

Answer: You provide a pretty good summary. In the US, CO2 has been injected into the subsurface to enhance recovery of oil from reservoirs. So quite a bit of experience has been developed with the practical side of things --- operation/design of equipment needed, as well as the movement of CO2 in (and out of) the subsurface. This does give us a useful track record, and there have been learnings along the way that have helped identify ways to improve safety and effectiveness. But we need to think about storage in the hundreds to thousands of years in the future so the 30 year track record does not answer all the questions we need to address.

John K

Also, some of the most attractive locations for geological storage are not oil reservoirs but rather very deep sand layers saturated with salt water called "saline aquifers". Utilization of these subsurface formations may have some differences from oil reservoirs.

Scaling up capture technologies and proving them is a significant challenge for CCS (and probably the largest portion of ultimate investment needed). But we still have more to learn about the subsurface as well.

Markus W

Question: Markus W: What happens to CO2 once it is stored underground? Does it degenerate over time? I am just wondering if we are placing a burden on future generations with the storage of "degeneration".

Answer: Hi Markus --
Over many years of experience in EOR and CCS we have quite a good understanding of the ultimate fate of the underground CO2. There are several mechanisms at work, and they operate at different time scales. In the short term, we rely on a porous reservoir that has a thick, impermeable cap rock to keep the CO2 from returning to the surface. As the CO2 moves through the rock a significant fraction of it is trapped as a "residual phase". It is like the oil that remains after an oil field is depleted, and is likewise trapped forever. Some of the CO2 then dissolves into the saline water present in the rock, and then tends to sink to even deeper depths, which

Rich

is a good thing. Depending on the minerals present in the rocks, the ultimate fate of some of the CO₂ (after 100's of years) will be in the form of minerals that are inert and are no longer CO₂. This last mechanism would be akin to your question

3P	Question: 3P: Follow-up for David re: 30 years' worth of CO ₂ deposition in the US...Was this for enhanced oil recovery? Is it still down there? How much and where? Sounds like excellent sites for research and study as well as sources of existing data?	Answer: You are correct. We can learn a lot from existing US operations. There are studies already completed on the effects of CO ₂ on well bores and various operational aspects (transport and injection). I did not see the original statement regarding 30 years worth of CO ₂ deposition in the US, however it is safe to assume that this refers to enhanced oil recovery. Companies have been doing this activity for years. Shell was a pioneer in this activity and continues to build on our industry-leading legacy from the Permian Basin in West Texas, where we developed a CO ₂ EOR program in the 1960s, and the worlds largest fully integrated CO ₂ value chain project in the 1980's.	Edward
jw8765	Question:jw8765: How much pressure is the CO ₂ gas normally stored at in the empty natrual gas reservoirs and empty saline aquifers?	Answer: Hi -- Thanks for your question. The pressures we would inject at are below the pressures at which the rock would tend to break ... the so-called rock fracture pressure. That insures the integrity of the reservoir and seal. In a depleted natural gas reservoir, the pressure may be much lower than the normal pressure of the surrounding rock, so the ultimate storage pressure after injection could be similar to the virgin pressure in the field. After injection stops the pressure tends to relax to its normal state in the subsurface.	Rich
jw8765	Question:jw8765: In this article http://en.wikipedia.org/wiki/Carbon_capture_and_storage it points out that there is some confusion in the US at least on whether CO ₂ is a commodity or a pollutant.	Answer: Thanks. The choice of words is important because the US legal/regulatory system has a wide variety of differing (and maybe even conflicting) requirements that could apply. Your point reinforces the importance of having clear regulatory requirements and frameworks established for CCS.	John K