Getting to a low carbon economy

Raymond Van der Putten

The Paris climate deal, concluded at the COP21 in 2015, pleads for keeping global warming below 1.5°C above pre-industrial levels. However, in its latest report, the IPCC (Intergovernmental Panel on Climate Change) warns that current mitigation policies are insufficient to obtain this objective. Investments in renewable energy and electricity infrastructure have to be stepped up. The power sector has to be decarbonised, the use of electricity increased, and energy efficiency improved. Low carbon policies are difficult to implement because of commercial interests and social impact, in particular concerning the increase in carbon prices. Nevertheless, to achieve substantial reductions in greenhouse gas emissions, a different approach is needed, including carbon pricing and trade sanctions.

In its report "Global Warming of 1.5°C" published on October 2018, the Intergovernmental Panel on Climate Change (IPCC), the UN organisation for climate analysis, warns that the earth is quickly warming up.[1] The increase in global mean surface temperature (GMST) since the period 1850-1900 is likely to be in the range between 0.75°C and 0.99°C in the decade 2006-2015.

In general, land surfaces warm up considerably faster than sea surfaces. Temperature extremes greater than GMST are already experienced in many land regions. The organisation attributes the increase in GMST with high confidence to past and ongoing emissions of greenhouse gases in the atmosphere. Global temperatures are rising currently by around 0.2°C per decade. The IPCC expects that at this speed global warming could reach 1.5°C by 2030 and 3-4°C by the end of the century.

The report emphasises the importance of limiting global warming to 1.5°C compared to 2°C, as the economic consequences of climate change should be more limited and would allow greater opportunities for adaptation.

Nevertheless, the consequences of an increase by 1.5°C could already be substantial. Because of an increase of sea levels in the range between 0.26 and 0.77 meter by 2100, low lying coastal areas are likely to be flooded and some small islands could completely disappear. This is 0.1meter less than in the 2°C scenario, implying that 10 million fewer people would be exposed to related risks. Biodiversity might be impacted, including species loss. Poverty is expected to rise in particular among people dependent on agriculture and activities in coastal areas. Some of it is already visible, such as the increase in weather extremes. Whereas several regions experience repeatedly heavy precipitations, other areas have been confronted with an increase in the frequency of droughts.

At the Conference of Parties in 2015 (COP21) held in December 2015 in Paris, 196 parties (195 States plus the European Union) concluded that global warming should be limited to 2°C and efforts should continue to limit global warming to 1.5°C. These objectives were confirmed at the COP24 in December 2018 in the Polish city of Katowice, but without adopting the necessary measures to achieve it.

The conference failed to endorse the IPCC report "Global Warming of 1.5°C" because of opposition from four oil-producing nations, the United States, Saudi Arabia, Russia and Kuwait. Important decisions, such as setting procedures for tightening of climate objectives and the long promised mobilisation of USD 100 billion financial support per year for climate adaption and mitigation projects in the developing countries were once again delayed to the next COP, to be held in Chili. The COP24 only succeeded at the last moment in accepting rules on measuring, reporting and verifying carbon emissions.

CO_2 emissions under different scenarios

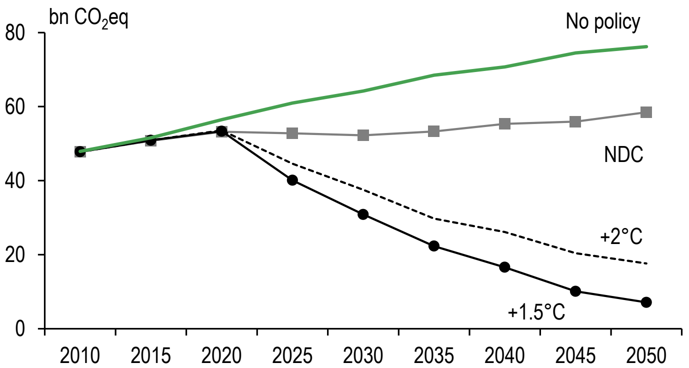

Chart 1 Source: McCollum (2018), BNP Paribas

Stepping-up and redirecting energy investment

The IPCC report underlines that achieving the transformation to a low carbon emission world requires major shifts in investment patterns away from fossil fuel investment toward renewal energy sources. Such a movement, albeit still modest, can already be observed.

In 2017, investment in low-carbon sources – including renewables and nuclear – reached more than 70% of total power plant investment from less than 50% a decade ago. Nevertheless, energy investment is on a declining trend, largely due to less investment in the power sector as a result of falling prices in particular for solar PV, which represents 8% of total energy investment. Solar PV projects commissioned in 2017 cost nearly 15% less per megawatt of capacity than in 2016 due to technology improvements and deployment in lower-cost regions, even

[1] https://www.ipcc.ch/sr15/

as capacity additions rose to record levels. In addition, fewer additions of coal, hydro, and nuclear power capacity were made.

Nevertheless, much of world's power generation continues to depend on fossil fuels. The share of fossil fuels, including thermal power generation, in total energy supply investment rose for the first time since 2014 to 59%. The sharp drop in investment in coal-fired power and coal supply was offset by heavy investment in the oil and gas industry, in particular in the US. This is not only related to the shale sector, but also to the downstream oil and gas industry. For the first time in recent decades, the US was the largest recipient of investment in petrochemicals.[2]

Current policies to reduce greenhouse gas emissions are insufficient to keep global warming below the 2°C. Model simulations show that the national climate objectives, or Nationally Determined Contributions (NDC) submitted before the COP21 in Paris, are rather timid compared to a no-policy scenario[3] (chart 1).

Annual energy investment is set to be increased to USD 2.586 trillion per annum compared with USD 2.481 trillion in the base line. Moreover greenhouse gas emissions in the NDC scenario are likely to increase, albeit less than in a no-policy scenario . In order to limit global warming to 2°C or even 1.5°C, greenhouse gas emissions should start to decline around 2020. In the 1.5°C scenario, they should be close to zero by 2050. This requires much more investment in sustainable energy infrastructure. In the 1.5°C scenario energy investment has to be increased by more than one third compared to the NDC scenario to USD 3.183 trillion per year.

The IPEE report shows several pathways for achieving the low carbon objectives. The mitigation strategies combine three crucial elements. First, the power sector needs rapidly to be restructured to avoid further locking into fossil fuel capacities, and increase the capacity of renewable energy sources such as solar and wind. In the NDC scenario, the share of renewable energy sources in total electricity is projected to increase from just over 30% in 2015 to around 70% by 2050. In the 1.5°C and 2°C scenarios, the power sector will be almost fully decarbonised by 2050 (chart 2). Second, energy efficiency has to be improved and the electrification in industry, transportation, and residential and commercial real estate stepped up. In the scenarios, energy efficiency, measured by the ratio between economic output to energy input, compared to the base run improves in all sectors. Even though in these scenarios GDP in purchase power parity (PPP) would increase by a factor of 3.3 from 2010 to 2050, final energy use hardly increases in the 1.5°C scenario (chart 3). Moreover, in the 2°C and 1.5°C scenario, the share of electricity in final energy use increases from 19% to 37% and 46%, respectively (chart 4). As electricity would be almost completely decarbonised in both scenarios, this would have a considerable impact on CO_2 emissions. Finally, CO_2 removal technologies have to be developed and upscaled. In the 1.5°C scenario, virtually all residual CO_2 emissions are removed by equipping fossil fuel installation with Carbon Capture and Storage or by Land Use and Soil Carbon Sequestration.

Electricity capacity from renouvelable sources

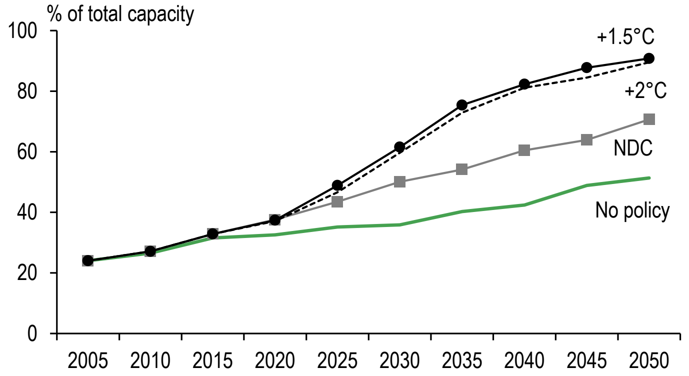

Chart 2 Source: McCollum (2018), BNP Paribas

Energy use virtually stable in a +1.5° C scenario

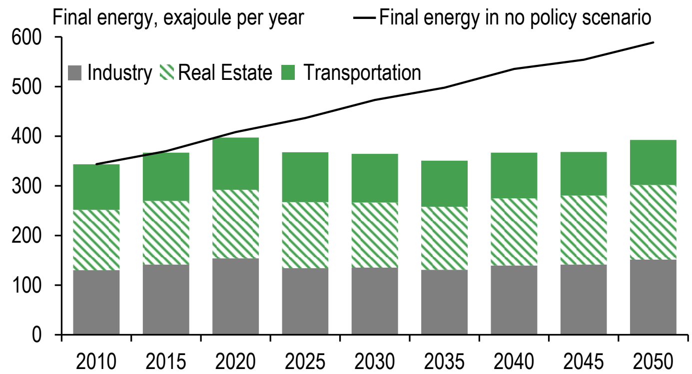

Chart 3 Source: McCollum (2018), BNP Paribas

Getting to low carbon pathways

In the scenarios, carbon prices are the main policy instrument to get the economy on the low carbon pathway. By increasing the price for fossil fuels, the carbon tax should make carbon-intensive production and consumption more expensive and create incentives for economic actors to turn to low carbon alternatives. For example, instead of constructing coal-based power stations, one could consider the construction of wind farms. The (tax) receipts obtained in this way could not only be used to pay for the necessary investment related to climate adaption but also to lower other taxes, such as income taxes. The macroeconomic effects should be close to neutral.

[2] *IEA,2018, World Energy Investment 2018, Paris.*
[3] The model simulations are made by six global integrated assessment models. They are reported in McCollum, David L., *et al.* "Energy investment needs for fulfilling the Paris Agreement and achieving the Sustainable Development Goals." Nature Energy (2018): 1. In this study, we only use the averages of the six models. The results are summarised in Table 1 at the end of the article.

The carbon tax level used in the simulation models is determined by the policy goal.[4] These vary substantially across models and scenarios and their value increases with the mitigation effort (chart 5). In the 2°C scenario, carbon prices range from USD 33 to 186 (2010) per tonne CO_2 in 2030. In the 1.5°C scenario, they would be in the band between 110 and 475 USD (2010). For comparison, the Report of the High-Level Commission on Carbon Prices projects a price between USD 40 and USD 80/tCO_2 by 2020 and between USD 50 and USD 100/tCO_2 by 2030 to be consistent with the Paris objectives.[5]

Unfortunately, carbon or green taxes are not extensively used worldwide. Less than 20% of current global greenhouse gases are covered by carbon prices, and most prices are well below USD 40-USD 60 per tonne of CO_2, the level recommended by the High-Level Commission on Carbon Prices for 2017. The situation is only slowly improving. According to the OECD, the carbon pricing gap, which compares actual carbon prices and real climate costs estimated at EUR 30 per tonne of CO_2, was 76.5% in 2018, only slightly lower than the 79.5% gap reported in 2015.[6] The carbon emission price gap is lowest for road transport (21%) and highest for industry (91%).

A different approach is needed

Simulations show that current pollution abatement policies are not sufficient for keeping global warming below 2°C. Moreover, the IPCC study shows that it would be much better if global warming would be limited to only 1.5°C. However, it is uncertain how investment flows can be increased and redirected to low carbon alternatives.

Although early signs of climate change have already appeared, many actors still deny the urgency for immediate action, as for most of them the catastrophic impacts will be felt well beyond the traditional planning horizons. As long as climate change does not seem a very pressing problem, it is very tempting to become free-riders and let the coming generations make most of the effort in cutting back greenhouse gases. The danger is that we get locked in a high carbon scenario, from which it is very costly to leave. Bank of England's governor Mark Carney called it "the tragedy of the horizons".[7]

Normally, governments should have a responsibility in overcoming such market failures through developing policies and appropriate regulatory environment. The COP is an effort to combat climate change at a supranational level.

For the corporate sector, the signing of the Paris climate deal was a signal to include the transition to a low carbon society in the business plans. Companies have started using an internal price of carbon for their business operations and investment decisions.

Since Mark Carney's speech, financial institutions have also become more aware of the risk of climate change for their operations. Institutional investors, such as investors and pension funds, increasingly incorporate environmental, social, and governance (ESG) factors into their investment analysis. It is one of the factors behind the surging demand for green bonds.[8] In France, article 173 of the energy transition law imposes extensive climate change-related reporting for asset owners and asset managers. The objective is to reduce the carbon footprint of the institutional investors. In the UK, the Bank of England has suggested the risk arising from climate change should form part of its annual stress tests for banks in 2019.

Share of electricity in final* energy increases in a +1.5°C scenario

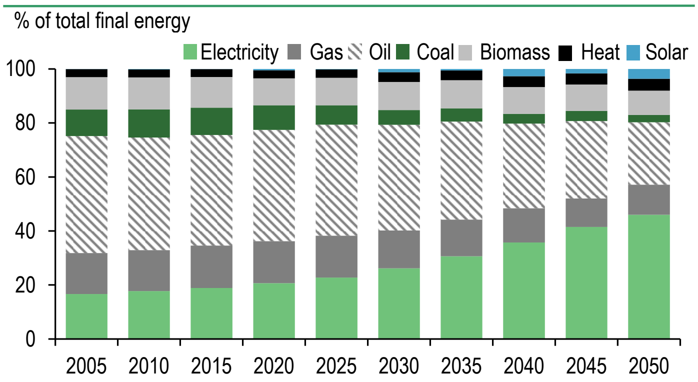

Chart 4 Source: McCollum (2018), BNP Paribas

Final energy consumption is the total energy consumed by end users, such as households, industry and agriculture. It excludes energy used by the energy sector (ex. processed fuel in power plants).

Carbon prices

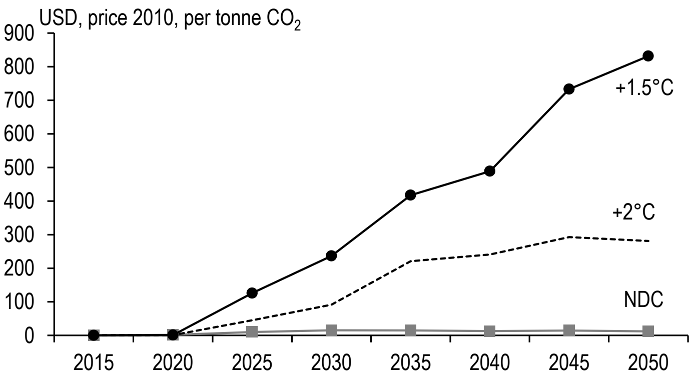

Chart 5 Source: McCollum (2018), BNP Paribas

Nevertheless, in general, progress in designing and implementing the necessary rules and regulations to achieve the Paris goals is very slow as not all governments share the same long-term vision. Some are held back by commercial interests. Fossil fuel supply and thermal power investment are increasingly dominated by state-owned enterprises.

[4] It differs from the social costs of carbon, a concept used in cost-benefit analysis. This is the total net damages, monetised and discounted of the release of one extra metric tonne of CO_2.
[5] Stiglitz, J.E. and N. Stern (2017), Report of the High-Level Commission on Carbon Prices.
[6] OECD, 2018, *Effective Carbon Rates 2018*, Paris.
[7] Speech by Mr Mark Carney, Governor of the Bank of England and Chairman of the Financial Stability Board, at Lloyd's of London, London, 29 September 2015.
[8] Raymond Van der Putten, 2015, *Climate change: An unprecedented investment and financing challenge*, BNP Paribas Conjoncture, October.

Moreover, the electorate might not be convinced of the necessity of taking active measures in particular if these are costly and may affect their lifestyles. The US government is leaving the Paris climate agreement as a substantial part of its voters doubts the veracity of climate change and fear that it could put US industry at a disadvantage.

Finally, reducing global emissions by fixing national objectives has turned out to be very complicated. A global quantitative target is easily translated in a global price target, as to each quantitative objective a shadow price – i.e. the optimal carbon price – is associated.[9]

The difficulty is that a global quantitative target is not easily translated into individual targets for each country. In the negotiations, each country has an incentive to keep the NDC as low as possible. In this approach it is easy to become a free-rider. The result is a set of about 200 individual quantitative targets which do not add up to the global objective.

From an economic view, a price target, or an environmental tax, is preferable to a quantity target. It is accordance to the principle that individuals and firms should pay the full marginal costs of the emission of carbon. Once the global price is set, all countries are free to design policies to achieve the carbon price and to recycle the proceeds of the tax. However, the implementation of a sufficiently high carbon price is rather problematic. One of the problems is that increases in carbon prices, or more generally in fuel prices, might result in redistribution problems and are often resisted. Users cannot change quickly to cheaper alternatives without incurring heavy costs. In addition, carbon tax hikes may disadvantage disproportionally rural populations that do not have access to good public transport. Lastly, for the tax payer, the link between carbon taxes and climate objectives is not always clear. These taxes could be perceived as just another way to finance the budget.

In 2018, a modest increase in French carbon taxes triggered off heavy street protests which forced the government in reversing the measure. Voters in Washington State also recently rejected a carbon tax. In this case, the tax would have been devoted to renewable energy projects and helping negatively affected workers. In order to gain the support from the trade unions, large industrial facilities would have been exempted. The full force of the measure would have fallen on oil refiners. In this context, it is not surprising that the refiners spent heavily to defeat the ballot proposal.

A solution could be the better framing of climate policy. Recently, George Shultz and Ted Halstead have proposed the so-called 'Carbon Dividends Plan'.[10] The idea is quite simple. A carbon fee will be levied and the proceeds, the so-called dividend, should be returned directly to tax payers through equal lump-sum rebates. They argue that such a programme would be very popular in the US as over two-thirds of American households would be financial winners, as they receive more in dividend payments than they would pay in increased energy prices. As the wealthier households tend to pollute more in absolute terms, they would face the highest costs. According to the authors, the bottom income deciles would experience the greatest net gains.

A yet unsolved problem is the so-called 'carbon leakage'. Carbon tax hikes, might induce enterprises to move their most polluting activities to countries with less strict environmental legislation. This would have a negative effect on industrial activity while at the same time hardly reducing global emissions. To solve the problem, William D. Nordhaus, the 2018 Nobel laureate in Economic Sciences suggests that countries could form coalitions, the so-called 'climate clubs'.[11] These groups agree on a carbon price emitted within their borders. This could be done either by a domestic carbon tax or a trade-and-cap system.

The coalition would impose tariffs at their borders on imports from the rest of the world, both to incentivise other countries to join and as a mean to restricting carbon leakage. Exporters to countries which do not apply a carbon tax would receive a rebate. Two options are possible to determine the size of the tariffs. A first approach is to set tariffs in relation to the carbon contents of imports. Such a tariff would remedy a competition distortion caused by the fact that producers outside the coalition would not be affected by the carbon tax. Some precedents suggest that such tariffs would be legal under WTO rules.[12] But there is a practical problem. It is impossible to work out the carbon contents of every import and some approximations are required. For this reason, Professor Dieter Helm suggests to concentrate on a small number of energy-intensive industries, such as steel and chemicals.[13] Nordhaus is in favour of the second approach, a uniform border tax. The advantage is that such a tax is simple to implement. Moreover, by setting the tax rate sufficiently high, countries have a financial incentive to join the coalition. Both options are likely to be legally challenged. It might require a change in international law to make such import taxes legal.

The major flaw of the COP and the Paris climate deal is that the process is rather non-committal. Countries can leave the deal without incurring sanctions, they are for the moment free to formulate their own objectives and there are no sanctions if these objectives are not met. Nordhaus concludes his above mentioned AEA lecture by noting that *"without sanctions, there is no stable climate coalition other than the non-cooperative and low abatement coalition."* By contrast, *"an international climate treaty that combines target carbon pricing and trade sanctions can induce substantial abatement"*.[14]

Completed on 24 January 2019

raymond.vanderputten@bnpparibas.com

[9] Raymond Van der Putten, 2011, *Climate change policy after Cancún*, BNP Paribas Conjoncture, September 2011, page 21.

[10] George P. Shultz and Ted Halstead, 2018, *The Dividend Advantage,* The Climate Leadership Council.

[11] William Nordhaus, 2014, *Climate Clubs: Designing a Mechanism to Overcome Free-riding in International Climate Policy*, Presidential Address to the American Economic Association, 4 January 2014, published in American Economic Review 2015, 105(44): 1339-1770.

[12] Joseph Stiglitz, 2006, *A New Agenda for Global Warming*, The Economist' Voice 3(7).

[13] Dieter Helm, 2010, *A Carbon Border Tax Can Curb Climate Change*, Financial Times, 5 September.

[14] Nordhaus (2014), op. cit. page 1368

Growth and energy projections (investment, capacity, consumption) 2020 to 2050

Average annual growth 2020-2050 (%)	**No policy**	**NDC**	**2°C**	**1.5°C**
World				
Population	0.6	0.6	0.6	0.6
GDP	2.7	2.7	2.6	2.6
Investment	1.7	1.8	2.5	2.9
- of which in low carbon	1.9	2.4	4.9	5.6
Final energy	1.2	1.1	0.3	-0.1
- of which electricity	2.3	2.2	2.2	2.6
Renewable energy capacity as % of total electricity capacity in 2050	37.1	55.9	76.6	86.5
CO_2 emissions in 2050 as % of no-policy scenario	-	-23.2	-82.3	-99.0
Africa and Middle East				
Population	1.5	1.5	1.5	1.5
GDP	4.4	4.4	4.2	4.1
Investment	3.0	3.3	3.8	4.6
- of which in low carbon	5.2	5.4	10.1	12.0
Final energy	2.2	2.2	1.1	0.8
- of which electricity	3.9	3.9	4.1	4.6
Renewal energy as % of total electricity capacity in 2050	27.2	31.0	58.0	75.7
CO_2 emissions in 2050 as % of no-policy scenario	-	-4.0	-80.8	-86.9
Asia (excl. Middle East, Japan, and former Soviet Union states)				
Population	0.4	0.4	0.4	0.4
GDP	4.0	4.0	3.9	3.9
Investment	1.7	1.8	2.9	3.5
- of which in low carbon	1.0	3.2	5.9	6.6
Final energy	1.6	1.5	0.6	0.4
- of which electricity	2.8	2.7	2.6	3.0
Renewal energy as % of total electricity capacity in 2050	35.3	56.4	86.2	97.2
CO_2 emissions in 2050 as % of no-policy scenario	-	-22.8	-83.5	-97.0
Latin America				
Population	0.5	0.5	0.5	0.5
GDP	3.1	3.1	3.0	2.9
Investment	2.6	2.6	2.8	3.0
- of which in low carbon	2.3	2.6	5.6	6.1
Final energy	1.5	1.4	0.7	0.6
- of which electricity	2.6	2.5	2.9	3.4
Renewal energy as % of total electricity capacity in 2050	51.6	60.0	66.1	67.7
CO_2 emissions in 2050 as % of no-policy scenario	-	-32.0	-100.6	-130.5
OECD(1990) & European Union				
Population	0.3	0.3	0.3	0.3
GDP	1.7	1.7	1.6	1.6
Investment	1.3	1.7	2.4	2.9
- of which in low carbon	1.6	2.6	4.9	5.4
Final energy	0.5	0.4	-0.3	-0.6
- of which electricity	1.2	1.2	1.5	2.1
Renewal energy as % of total electricity capacity in 2050	40.6	61.8	71.4	85.1
CO_2 emissions in 2050 as % of no-policy scenario	-	-36.6	-79.5	-101.0
Russian Federation & other ex-Soviet Union states				
Population	0.0	0.0	0.0	0.0
GDP	2.8	2.8	2.6	2.5
Investment	2.4	2.6	2.1	2.1
- of which in low carbon	2.5	2.6	6.5	7.2
Final energy	0.8	1.7	-0.4	-0.9
- of which electricity	1.8	2.8	1.4	1.8
Renewal energy as % of total electricity capacity in 2050	24.7	35.4	65.1	78.5
CO_2 emissions in 2050 as % of no-policy scenario	-	-5.1	-85.2	-102.1

Table 1 Source: McCollum (2018), calculations BNP Paribas

GROUP ECONOMIC RESEARCH

William DE VIJLDER Chief Economist	+33(0)1 55 77 47 31	william.devijlder@bnpparibas.com

ADVANCED ECONOMIES AND STATISTICS

Jean-Luc PROUTAT Head	+33.(0)1.58.16.73.32	jean-luc.proutat@bnpparibas.com
Alexandra ESTIOT Works coordination - United States - United Kingdom - Globalisation	+33.(0)1.58.16.81.69	alexandra.estiot@bnpparibas.com
Hélène BAUDCHON France (short-term outlook and forecasts) - Labour markets	+33.(0)1.58.16.03.63	helene.baudchon@bnpparibas.com
Louis BOISSET European central bank watch, Euro area global view, Japan	+33.(0)1.57.43.02.91	louis.boisset@bnpparibas.com
Frédérique CERISIER Euro Area (European governance and public finances),Spain, Portugal	+33.(0)1.43.16.95.52	frederique.cerisier@bnpparibas.com
Catherine STEPHAN Nordic countries - World trade - Education, health, social conditions	+33.(0)1.55.77.71.89	catherine.stephan@bnpparibas.com
Raymond VAN DER PUTTEN Germany, Netherlands, Austria, Switzerland - Energy, climate - Long-term projections	+33.(0)1.42.98.53.99	raymond.vanderputten@bnpparibas.com
Tarik RHARRAB Statistics and Modelling	+33.(0)1.43.16.95.56	tarik.rharrab@bnpparibas.com

BANKING ECONOMICS

Laurent QUIGNON Head	+33.(0)1.42.98.56.54	laurent.quignon@bnpparibas.com
Laure BAQUERO	+33.(0)1.43.16.95.50	laure.baquero@bnpparibas.com
Céline CHOULET	+33.(0)1.43.16.95.54	celine.choulet@bnpparibas.com
Thomas HUMBLOT	+33.(0)1.40.14.30.77	thomas.humblot@bnpparibas.com

EMERGING ECONOMIES AND COUNTRY RISK

François FAURE Head	+33.(0)1 42 98 79 82	francois.faure@bnpparibas.com
Christine PELTIER Deputy Head - Greater China, Vietnam, other North Asian countries, South Africa	+33.(0)1.42.98.56.27	christine.peltier@bnpparibas.com
Stéphane ALBY Africa (French-speaking countries)	+33.(0)1.42.98.02.04	stephane.alby@bnpparibas.com
Sylvain BELLEFONTAINE Turkey, Ukraine, Central European countries	+33.(0)1.42.98.26.77	sylvain.bellefontaine@bnpparibas.com
Sara CONFALONIERI Africa (Portuguese & English-speaking countries)	+33.(0)1.42.98.43.86	sara.confalonieri@bnpparibas.com
Pascal DEVAUX Middle East, Balkan countries	+33.(0)1.43.16.95.51	pascal.devaux@bnpparibas.com
Hélène DROUOT Korea, Thailand, Philippines, Mexico, Andean countries	+33.(0)1.42.98.33.00	helene.drouot@bnpparibas.com
Salim HAMMAD Latin America	+33.(0)1.42.98.74.26	salim.hammad@bnpparibas.com
Johanna MELKA India, South Asia, Russia, Kazakhstan, CIS	+33.(0)1.58.16.05.84	johanna.melka@bnpparibas.com

Michel BERNARDINI Contact Média	+33.(0)1.42.98.05.71	michel.bernardini@bnpparibas.com

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