



climate change,
energy,
& businesses



quantifying
impacts
to 2040



About this report

Climate change, energy, & businesses – quantifying impacts to 2040

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SolAbility is a sustainability service provider based in Korea, providing sustainable management advice to corporate clients and advanced sustainable investment research covering Pan-Asian equities for institutional investors.

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climate change,
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& businesses



foreword

foreword

Sustaining Business to 2040

Current available facts indicate that

- Climate change is real, and leading to increased frequency of extreme weather events
- The end of a century of cheap oil. While there is no immediate danger of oil shortages,, the decline of easy accessible and exploitable fields, increasing demand from emerging economies, and commodity speculation suggests that cost of fossil energy resources will further increase in the future.
- There is no reason - neither technical, economical, nor financial - why the world economy should not be powered by renewable energy technologies and sources by 2040. However, a comprehensive energy infrastructure transformation would require political consensus within, and in between countries coupled with orchestrated investments.
- However, the complete absence of vision and leadership amongst politicians around the globe means that such a scenario is extremely unlikely. While some roadmaps might be developed on national and possible intra-national levels, the possibility of investments on the scale required to adequately tackle energy infrastructure transformation or climate change can virtually be excluded. Regardless of the fact that an energy Marshall plan would be significantly cheaper than a business-as-usual approach.

In other words: businesses will need to develop their own strategy and formulate answers to deal with the increasing impacts of climate change (mainly the increase of frequency and ferocity of extreme weather events on supply and resource constraints, operations, market access, and possible declining economy) and significantly rising energy costs.

This report presents the analysis and quantifies the impacts of climate change and rising energy costs on different industry sectors to 2040 under three possible scenarios.

We hope you find the lecture interesting.

Andy Gebhardt, CEO

Mi Hyang Lee, Managing Director





climate change,
energy,
& businesses:
left out in the cold



1

executive summary

Executive summary

Sustaining Business

Individuals might have ideological values. Corporations don't. Businesses have a balance sheet. Continued business success is a function of management capabilities in terms of planning, efficiency, innovation, marketing, and wider national/global economic developments. Management capability is controlling costs and developing products and services that customers need or want. The key ingredient to sustain business success is the ability to recognise and adapt to changing external factors.

One of the external factors is the energy-climate change nexus.

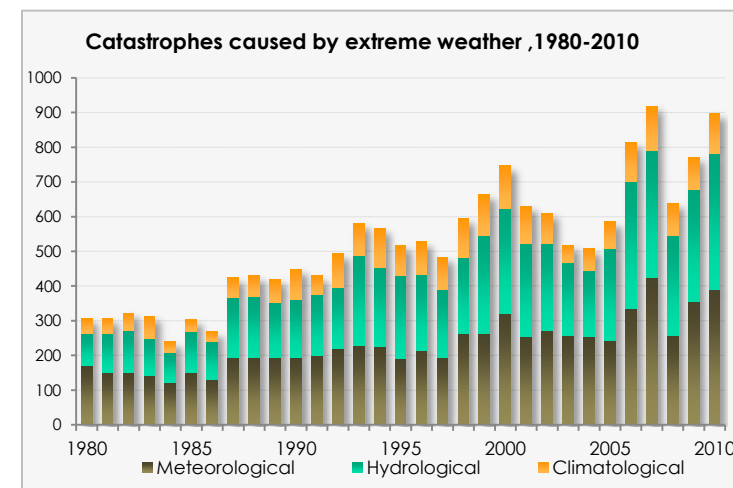
Climate change, energy, politics, and businesses

There is no reason - in technical and financial terms, there is no reason - why the World should not be powered by GHG-free renewable energy in 2040. However, such a scenario would require clear strategic guidance by the public sector through incentives, kick-starting large-scale investments, and complete removal of the current market distortion in favour of the fossil energy industry through direct, indirect and hidden subsidies.

Given the global political non-consensus regarding climate change and the complete absence of a vision for the future amongst the political elites, there is very little chance for the required energy transformation in reasonable timeframe to stabilise GHG emissions that would limit CO₂ concentration below the 350 ppm required to keep the global temperature from rising more than 2 degrees. Climate change does not only lead to rising temperature, but maybe more devastatingly, to increasing frequency and ferocity of extreme weather events (heat waves, cold fronts, torrential rains, and storms) and subsequent droughts, wild fires, floods, spring-floods, and landslides. Apart from potentially serious impacts on the food chain and food security, these impacts might lead to direct business bottom line impacts through damage to facilities, disruption of operations and supply, transport, and access to markets. The lack of incisive strategic direction setting on part of governments is leading to :

- Steeply increasing energy prices (i.e. cost to business) post 2015 due to simultaneously rising demand and scarcity (due increasing cost for extracting "unconventional" fossil energy and lack of meaningful investments in alternative energy generation)
- Increasing market volatility and business disruption due to extreme weather events

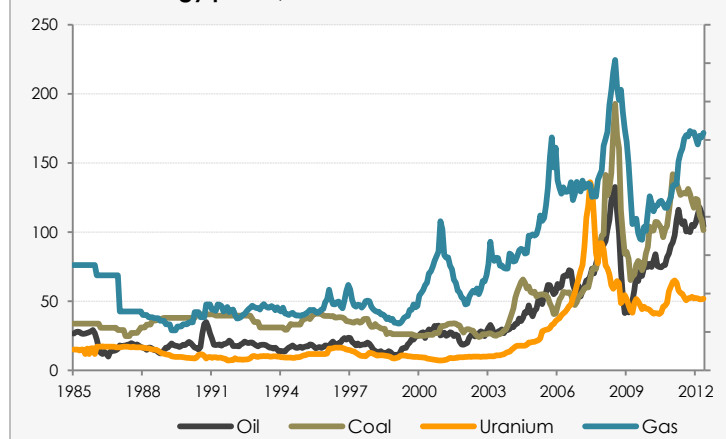
In the absence of political guidance, businesses will need to find their own strategic answers to these challenges. This report presents an analysis of the bottom-line impacts of climate change and the energy question to 2040 on different business sectors.



Increasing frequency of catastrophes caused by extreme weather events
Source: Munich Re

Oil price developments

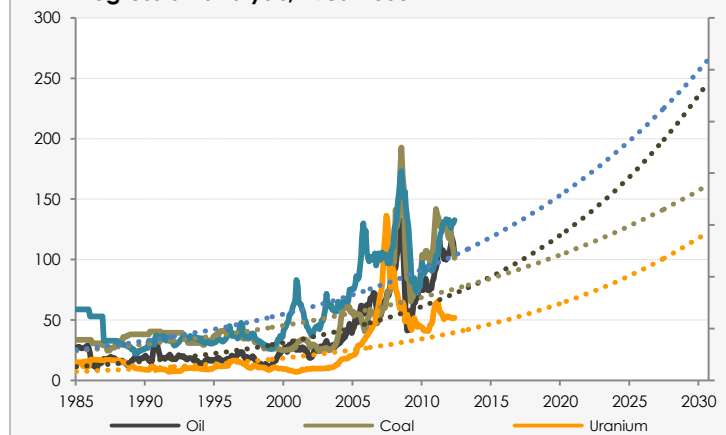
Fossil energy prices, 1985-2012



Increasing energy spot prices and correlation between energy carriers

Source: BP, IMF, World Bank

Regression analysis, 1985-2030



Future trend regression analysis of fossil & nuclear energy sources based on 1985-2010 trends

Energy costs

The global economy has been built on, and is fuelled by, fossil energy, mainly oil. Oil has a high energy density, can easily be transported, and is comparably safe, making it the energy carrier of choice, particularly in transport. Last but not least, the plentiful availability and easy physical accesses made oil a cheap energy form. Until recently, at least. After hovering between 20 to 30 U\$/barrel for more than 2 decades, the global spot-price has increased significantly since 2003, with a spike of more than 130U\$/barrel. It is also noteworthy that the spot-prices of oil, gas and coal are interwoven: increase and spikes are happening nearly simultaneous, i.e. substitution of oil with gas or coal is not an economically valuable option to counter rising oil prices. The reasons for the increase and hikes is a combination of factors:

- Increasing demand (in particular from the emerging economies)
- Slower increasing production (i.e. a lower supply-demand surplus margin)
- Geopolitical events
- Market expectations
- Commodity trade (i.e. speculation in the form of derivative financial products based on commodities)

For businesses, the reasons of the oil price increase is not important. What is important is that energy costs are increasing. Depending on the operational energy intensity or sensitivity of products, rising energy cost have a negative impact on businesses cost structure and market developments.

Oil, gas, coal & uranium price correlations

The markets react to real or perceived demand-supply imbalances. Perceived threats to oil security immediately have an affect on other fossil energy carriers, gas and coal, and interestingly also on uranium fuel.

Price trends

A simple regression analysis of the oil price developments of 1985-2012 extrapolated to the future would lead to an per-barrel price of more than 240U\$ by 2030. A regression analysis does not take into account technical developments and the limitations of fossil resources, i.e. there is a very high possibility that real prices will be higher than the results of a simple regression analysis.

Peak oil

Peak oil

"Peak oil" refers to a time in the future when global oil output is peaking before declining due to exhausting natural reservoirs. The Hubbert curve shows that oil field production starts to decline rapidly after a peak due to geophysical reasons. Oil production in Texan oil field have declined by more than 70% since peak production in the 1970s, for example. The calculation of the global oil production peak depends on remaining resources and availability and access to "unconventional" resources (deep sea, tar sands, arctic), i.e. is a highly complex matter. Peak oil predictions have been made by semi-governmental organisations (the International Energy Agency, IEA, the US EIA), market players (BP, Exxon, Total), and independent researchers. It is therefore not surprising that predictions of the peak oil time are differing significantly, with peak oil point estimated between 2012 (independent researchers) and post 2030 (Exxon). The mean peak oil point of the most predictions is 2018. Peak oil is leading to a drastically altered supply-demand balance, sharply increasing oil prices.

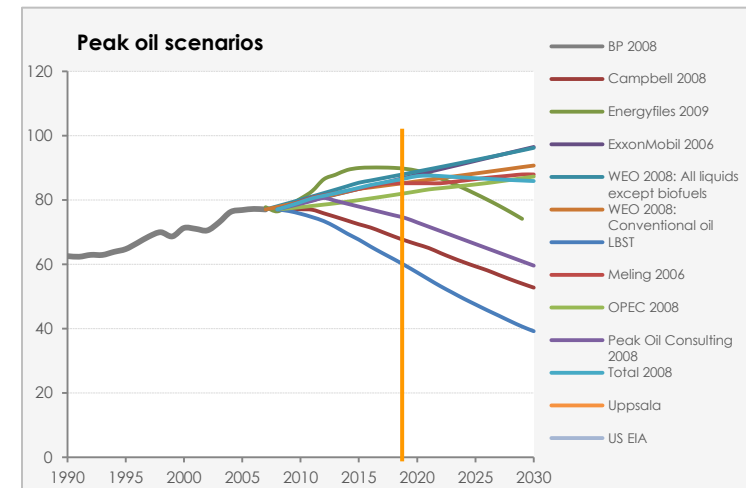
Peak oil predictions

Oil production forecasts have been made for decades. From a business perspective, it is interesting to note that past predictions presented by conservative agencies have been overly positive without failure. IEA and EIA predictions made in 2003 and 2005 for example show that future predictions for 2010 have overestimated actual production by 5-10%. The significance of this wrong predictions lies in the fact that the same organisations estimate peak oil not to happen before 2025, i.e. later than the average peak oil prediction.

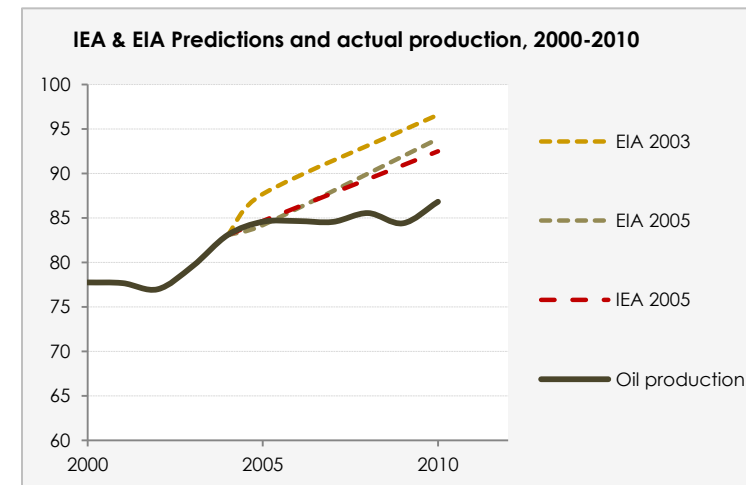
Due to the complexity of the matter, it is impossible to exactly predict the peak oil point. However, once oil production peaks, energy demand is bound to outstrip supply in the absence of meaningful and timely investments in viable non-fossil alternatives – and there is no sight of such investments at this time. Whenever oil is eventually going to peak, the spot price is going to increase significantly. Market expectations will lead to fluctuations, spikes and overall increase long before the peak will actually happen.

Tapping unconventional resources might delay peak oil. However, technological barriers and exorbitant exploration cost might make alternatives a viable substitution to oil. The meaning of peak oil for business is that that the current high oil and energy costs are not a temporarily phenomena, with a very high chance of further significant increase of energy costs.

High energy cost are here to stay, and will increase further in the future - a cost reality businesses have to adapt to. High energy efficiency reduces costs compared to peers. Energy efficiency is becoming a factor of competitive advantage.

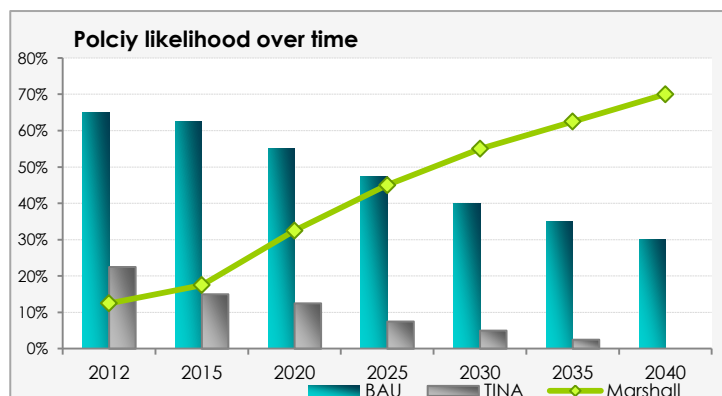
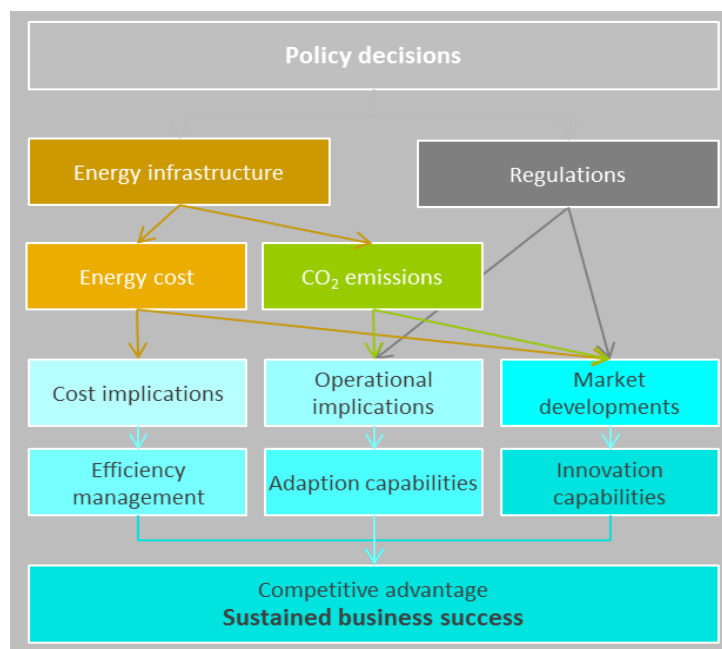


Comparison between different peak-oil scenarios. Average prediction: 2017-2020



Past IEA and EIA predictions against actual developments

the scenarios



Three scenarios

The environment that guides business operations and strategic decisions are shaped by policy decisions (taxes, tariffs, regulations). Equally, the characteristics of the future energy infrastructure (and the associated CO₂ emissions that influence the level of climate change) are shaped through tax systems, incentives, regulations, definition of mandatory standards, and public investments. The analysis of the bottom-line impacts of the climate change – energy nexus on different businesses and industry has therefore been conducted based on 3 different policy scenarios:

- **BAU scenario (Business As Usual)**

This scenario assumes that future developments continue along the lines of current policies. This approach is characterised by very limited intervention or active strategy setting on part of governments, i.e. future developments are mainly guided by “the markets”. However, rising energy cost will lead to the implementation of some of the Marshall policies as described below over time.

- **Marshall scenario**

This scenario assumes that governments of key economies define and implement a “Marshall plan” to transform national energy infrastructures through abolishment of current direct, indirect and hidden subsidies for fossil energy, and large-scale public investments in renewable energy technology and generation capacity to kick-start economics of scale, fast-tracking the road to economic break-even of renewable technologies.

- **TINA scenario (There Is No Alternative)**

The TINA scenario is based on the assumption that faith-based “there-is-no-alternative” approach to government and national development (as we are currently witnessing in a number of countries in Europe) is prevailing in most key economies, leaving economic development, energy infrastructure and climate change initiatives purely in the hands of “the markets”.

Each of these scenarios has different business implications on the cost management, operational, and product/service development level.

The detailed underlying assumptions for each scenario are described in [Chapter 3 of this report](#).

Scenario implications

Energy cost measuring

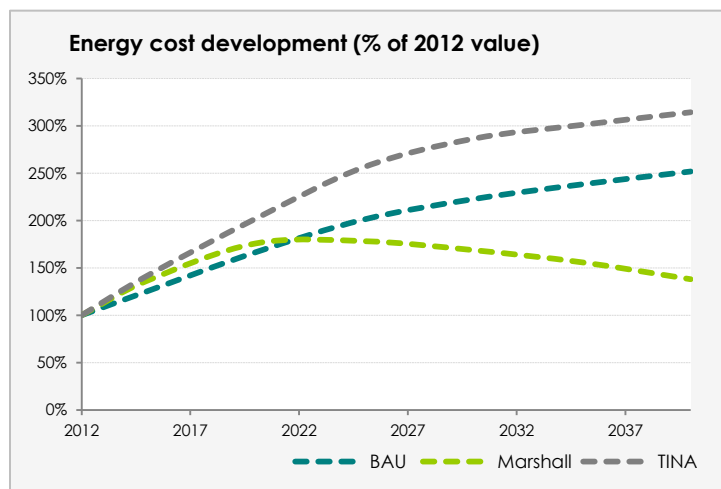
The price for a barrel of crude oil is currently the most widely used indicator for energy prices. However, businesses mostly use electricity, natural gas, and petroleum products as energy sources. The cost of energy (and energy efficiency) is based on the cost or price per end-user energy unit consumed. For the purpose of this analysis, primary energy carrier price developments (oil, gas, coal, etc.) served as basis to calculate the end-user energy cost in U\$ per MWh, taking into account energy technology developments .

Scenario energy cost development trends

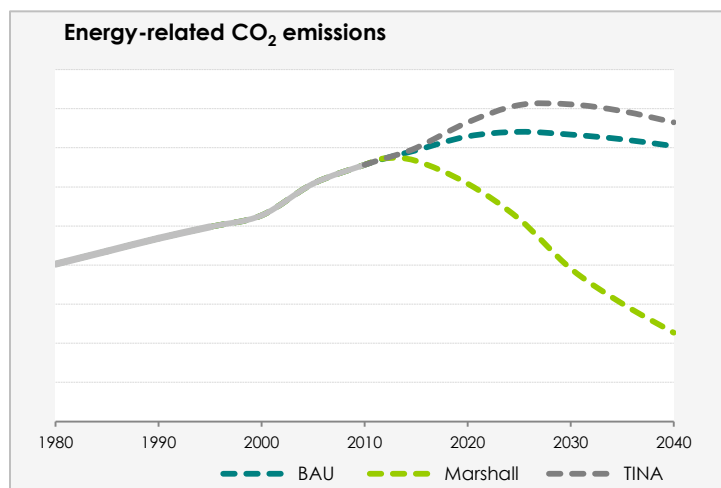
Due to relative scarcity of the fossil energy (oil), combined with rising demand (mainly from emerging economies) and market expectations, end-user energy costs (energy cost to businesses) are significantly rising under all three scenarios. Under the BAU scenario, energy costs to businesses remain marginally lower compared to the Marshall scenario until 2020 (due to the abolishment of existing indirect and hidden subsidies and the requirement for high initial investment in renewable capacities under the Marshall scenario). However, after 2020, energy cost pressure will start to ease under the Marshall scenario after 2020 due to the availability of viable and sufficient alternatives. The lack of viable alternatives under the BAU scenario leads to further rising energy cost throughout the 2020s and 2030s. Due to the lack of meaningful market interventions and provision of sufficient incentives to form a basis for large-scale alternatives, energy cost will rise significantly higher under the TINA scenario compared to both the BAU and Marshall scenarios. (refer to [Chapter 3](#) for details on future energy cost developments)

Energy-related CO₂ emissions & climate change

Due to the large-scale application of renewable energy technology (emission free in operations) under the Marshall scenario, energy-related CO₂ emissions are starting to decline towards the end of the current decade. However, due to the inertness of the climate system, climate change impacts will nevertheless rise until 2030 or 2040 before slowly subsidising. Energy-related CO₂ emissions under the BAU scenario are expected to rise until the middle of the 2030, leading to more severe impacts post 2030 compared to the Marshall scenario. Under the TINA scenario, the market will turn to the cheapest alternative as a substitute to dwindling oil availability and rising prices: coal, which also generates significantly more CO₂ emissions. Climate change effects, in particular extreme weather events and natural catastrophes are expected to increase significantly in ferocity and frequency until after the middle of this century before stabilising towards the end of the 21st century.

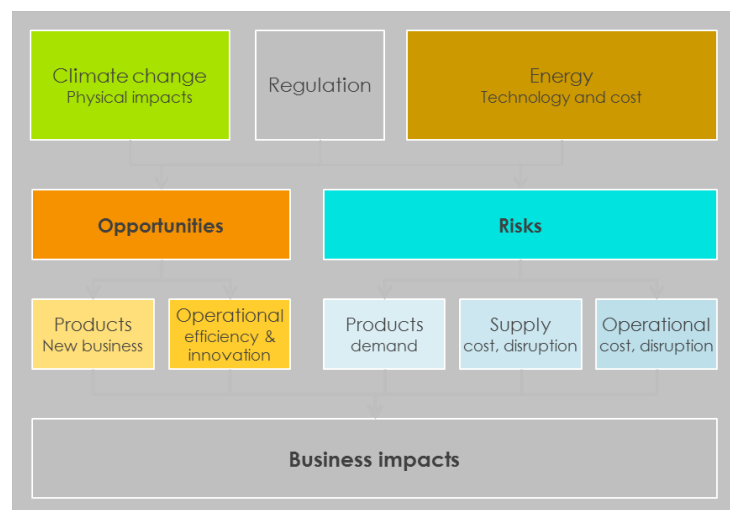


Development of future end-user energy costs under three different scenarios



Future GHG emissions associated with energy exploitation and energy usage under three different scenarios

Impacts on businesses



Climate change and energy: how they impact the business bottom-line

Climate change & energy - business impacts

The climate change-energy nexus and potential related regulations are affecting companies in various ways, both in terms of increasing cost (risks) and opportunities (development of products and services related to climate change and energy scarcity).

Climate change

Direct impacts of climate change are limited for the time being, but increasing with the rise of frequency and ferocity of natural disasters caused by climate change (draughts, floods, storms, landslides, etc.). Natural disasters can cause damage to physical company facilities and installations, and temporarily disrupt operations and supply (both through disruption of transport means and disruptions in the supply chain), i.e. lead to increase instability and frequency of unforeseeable force majeure events. Direct bottom-line impacts include higher investment and maintenance costs, as well as potential operational disruption and disruption of access to market, negatively affecting capacity utilisation rates. Indirect bottom-line impacts include higher procurement cost, and higher insurance policies.

Energy

Rising energy costs have an immediate impact on the bottom-line of businesses. Depending on the industry and business fields companies, energy is a cost factor that cannot be ignored. In some industries, the impact of the future rise of energy costs is equal or higher than their current profit margins. While rising operational costs can be passed on to customers to some extent, more efficient companies – both in their own operations and in their supply chain – gain competitive cost advantage, i.e. higher margins. Energy efficiency is therefore a key success factor in energy intensive industries. On the opportunity side, energy scarcity and the transformation of the energy infrastructure offers immense new business fields and opportunities.

Regulations

Operational or product/service regulations might require changes to operational procedures and product approvals. However, considering the lack of political will and put in perspective of a corporate balance sheet, the bottom-line impacts of potential future regulations related to climate change are expected to remain insignificant. Market-based instruments, such as cap-and-trade systems, have shown to be overly complex and therefore ineffective. In the absence of a global consensus, the relevance of such system on the business bottom-line remains negligible.

Quantifying the impacts: 2012 - 2040

Quantifying the impacts on selected industry sectors

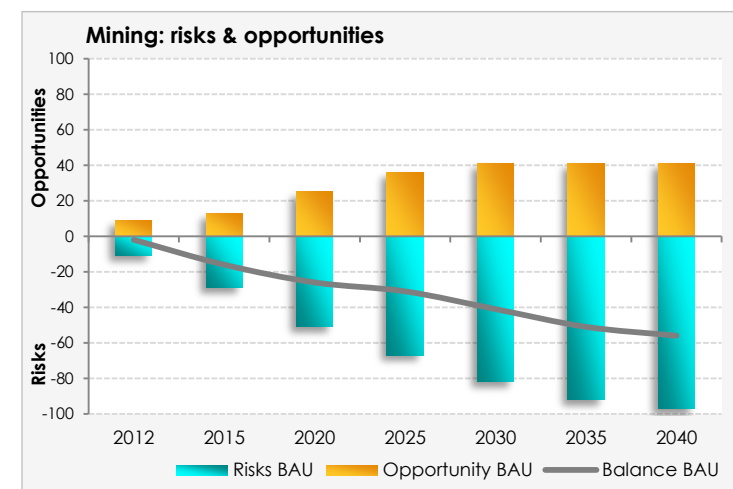
Based on the scenario assumptions and calculations, quantified impacts on the different industry sectors have been calculated to 2040. The impact analysis takes into account energy cost, climate change developments, and technology advancements. The analysis separately calculates risks impacts (cost) and opportunities (increasing competitiveness through process efficiency, capitalising on climate change & energy opportunities through innovative business development).

Energy industry: the fossil energy industry is enjoying a few more highly profitable years driven by high oil prices. However, exploration of new unconventional resources combined with increasing physical impacts of extreme weather events drives cost, and the emergence of cost-competitive renewable alternatives is putting pressure on profit margins after 2020 (BAU scenario). Oil, gas and coal companies have to consider their identity as Oil companies or energy companies.

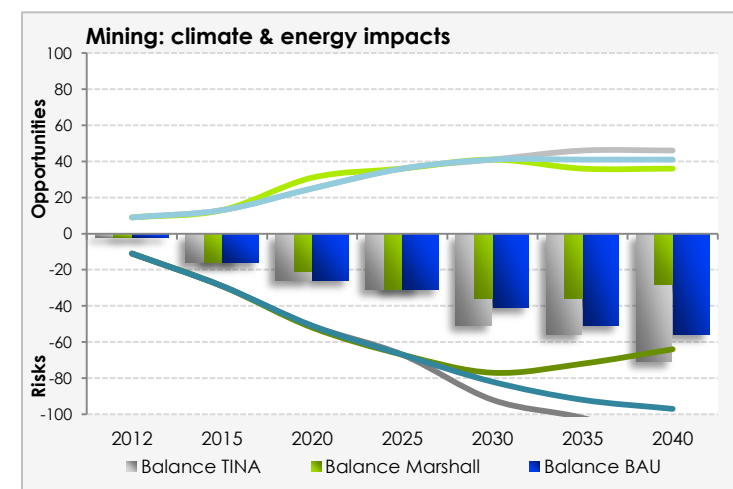
Mining industry: The mining industry's operational and transportation cost will increase with rising energy cost. However, considering that there are currently no substitutes available for most mining products (metals), the industry will likely be able to pass increasing cost on to customers if required. In addition, market expectations and increasing demand are leading to sizeable margins in the mid-term future. However, the physical impacts of climate change in the form of extreme weather events are increasingly affecting mining operations leading to higher investment and maintenance costs 2020 onwards. In addition, increasing water scarcity might lead to operational problems in some parts of the World.

Metals: The metal industry is highly energy intensive. In addition, raw materials are becoming more expensive with rising energy cost and climate change impacts. Process efficiency and innovation coupled with the establishment of a comprehensive scrap metal recycling chain in order to gain independence from fluctuating market prices are key success factors going forward.

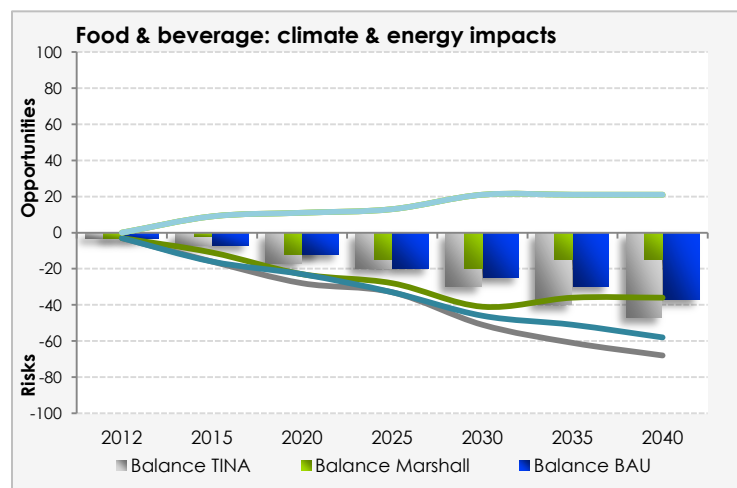
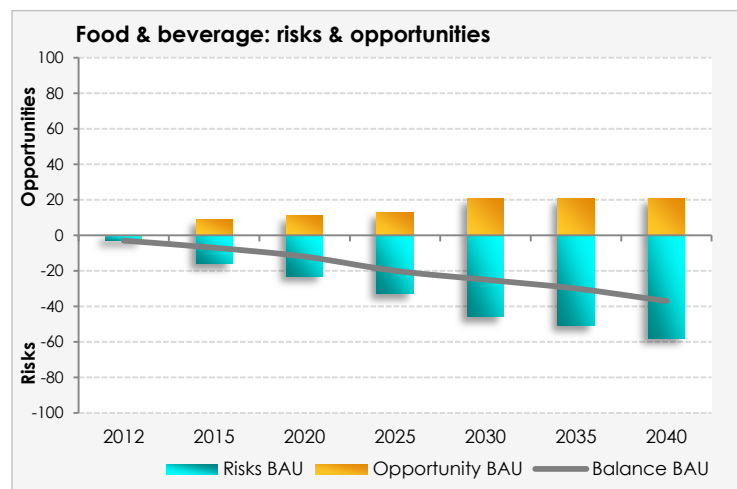
For details of quantitative impacts on different industry sectors, please refer to [Chapter 4](#) of this report.



Quantifying risk & opportunities in the mining industry under the BAU scenario please refer to [Chapter 4](#) for impacts on other industries



Comparison of quantified risks & opportunities in the mining industry under the 3 scenarios.



Quantifying the impacts on selected industry sectors (continued)

Manufacturing industrials: depending on the business field (heavy industry vs. light industry), rising energy cost will change the cost structure of businesses, requiring investments in efficiency. At the same time, rising energy cost and the eventual transformation of the energy infrastructure present sizable new business field and opportunities for smart and innovative solutions.

Automotive: consumers have been surprisingly resistant to rising fuel cost in their product choices, proofing the unique status of cars as a status symbol. However, with further rising energy cost and younger generations less keen on the status value, efficiency consideration are becoming an increasingly important purchase factor. However, increasing demand from emerging economies will offset this decline for some time to come. On the long-term, car manufacturers will have to consider their corporate identity as car maker or mobility providers.

Financial industry: direct operational implications of climate change and energy costs are marginal in the financial industry. However, insurance companies and project financiers need to develop comprehensive risk tools that take into account the new risk set. On the positive side, the energy transformation presents immense and profitable investment opportunities, and climate change offers new business fields for innovative insurance products.

Food & beverages: rising energy cost will have a rising an impact on the food and beverage industry. However, the industry will be mostly affected by climate change impacts in the supply chain – agricultural production. Extreme weather events - heat waves, draughts, followed by torrential rain and spring floods is expected to have a significant impact on harvest volumes and quality in the absence of timely counter-measurements (adaption of plants to the changing climate, protective installations, intelligent irrigation)

Communication services: energy cost for running and cooling IT infrastructure is a significant cost factor in the IT service industry. Technological advancements are expected to offset some of the increasing energy cost. Application of state-of-the-art equipment is therefore a key cost factors. New technologies provide considerable potential for new applications and services related to energy efficiency and climate change mitigation.

For details of quantitative impacts on the different industry sectors, please refer to [Chapter 4](#) of this report.

conclusions

Underestimated risks – and grossly underestimated opportunities

Policy decisions

- **Risks to businesses would be lowest and business opportunities highest under the Marshall scenario**, which is based on the assumption of swift implementation of an energy transformation roadmap through strategic guidance, tax and incentive revision, and large-scale investment
- However, the BAU (business-as-usual) scenario is the most likely policy scenario. Ironically, policies that are intent to sustain national competitiveness through a **business-as-usual approach significantly increase risks to businesses and negatively affect opportunities** post-2020

The energy question

- The future price of energy and its implications on operational costs to businesses are still underestimated by most businesses
- **Energy management and energy efficiency, are becoming key competitiveness drivers** in many industries, in particular in energy intensive industries
- The **cost savings potential of energy efficiency** measurements and investments is still **undervalued**
- **Business opportunities** related to energy efficiency and renewable energy (both in terms of products and services) **are still grossly underestimated**

Climate change impacts

- **Climate change will lead to increased and unforeseeable business disruptions** through higher frequency and ferocity of extreme weather events
- **Extreme weather events are leading to disruption and higher cost in the supply chain** in all industries directly or indirectly depending on natural resources (metals, agriculture, petroleum products)

Other than companies directly financially affected on such events (i.e. the re-insurance industry), **most business are not sufficiently prepared for the expected climate change impacts.**





climate change,
energy,
& businesses



2

background

2. climate change, energy, businesses

Climate change

The Global Climate is a natural system of immense complexity, determined by an endless number of single factors that often interact and feedback into each other. The balance of this system has provided the basis of all life, and has allowed humanity to flourish and build the civilisation as we know it today.

Like every interacting system, the climate system is prone to system imbalances and/or adjustments when certain factors are changing. All available theoretical, empiric and modelled evidence indicate that changes are, and have been, underway for some time. While the full extent and impacts are not yet known, the physical impacts of a changing climate system is a new reality businesses have to adapt to in order to remain profitable.

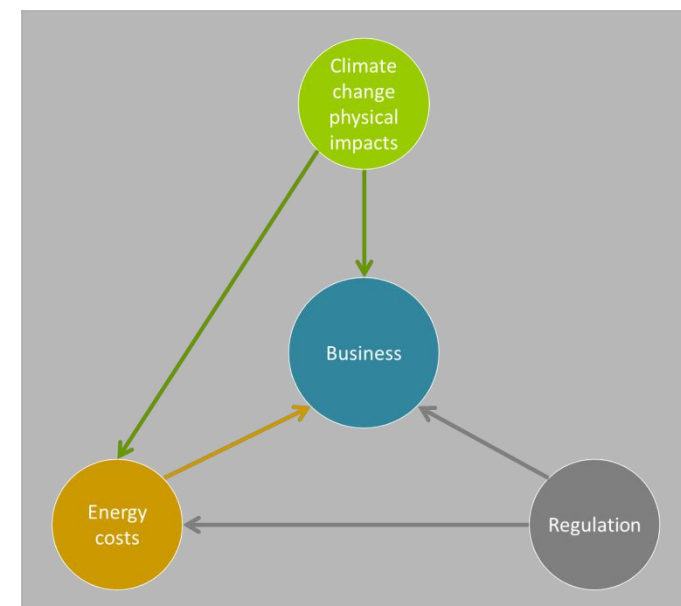
Energy

Climate Change is a phenomenon that is - to a significant part - attributed to human consumption of fossil energy through burning fossil fuels, gas, and coal. At the same time, the easily accessible and exploitable (i.e. cheap) fossil fuels our civilisation and industries are built upon have peaked or are peaking. While further fossil resources are available, exploration costs for so-called "unconventional" sources are incomparably higher.

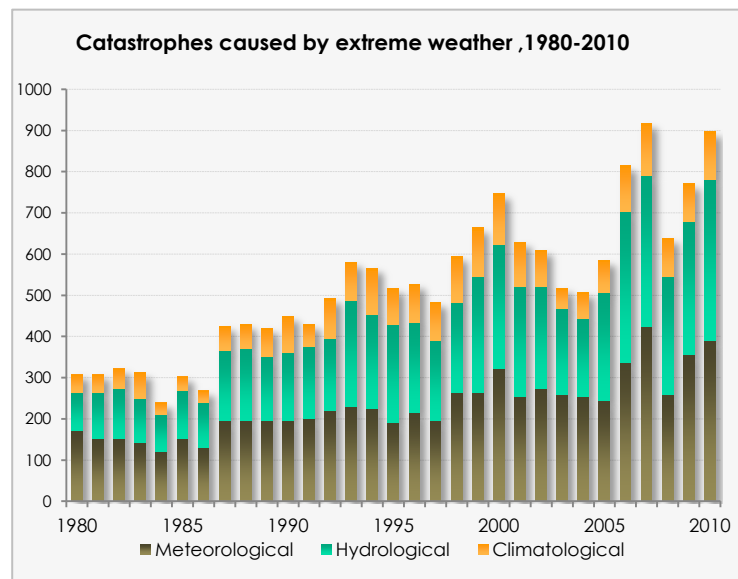
Regardless of direct climate change impacts, potential regulations, or government policy choices, energy costs are set to increase significantly. What we have been witnessing in recent years is just the beginning. Depending on the business sector, companies are large consumers of energy. Rising energy cost will significantly alter the cost structure in several industry sectors. At the same time, the energy challenge represents vast new opportunities for fast movers, innovative technology and services.

Politics & regulations

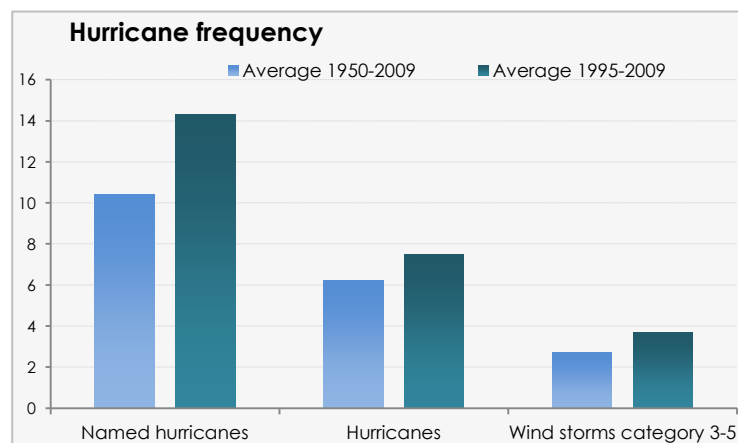
Government regulations and climate treaties potentially could influence operational management requirements, and energy cost through changes in subsidy and tax policy. However, considering the lack of global consensus and government tendencies to avoid real or perceived threats to the national competitiveness, the influence of regulation on business operations and cost/profit structure is expected to remain insignificant.



2.1 Climate change



Source: Munich Re



Extreme weather events

Climate change is – and will – affect different people in different locations in different ways. Relevant studies suggest that poorer nations in the South will be more directly affected by changes of the climate than the richer nations (and main emitters of greenhouse gases) in the North. However, addressing the moral and ethical aspects and dilemmas of climate change is not the aim of this analysis.

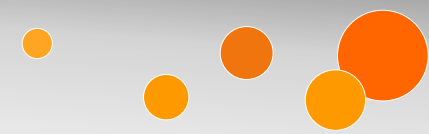
Businesses are entities. Individual employees do have a conscience and personal moral or value systems, but corporations – by their nature – do not. They have a balance sheet. The corporation's responsibility is towards its customers (to deliver the promised good/service), to its owners/shareholders (by remaining profitable, and not going bankrupt), and authorities by compliance with laws. Climate Change – from a corporate perspective – is therefore a physical phenomenon that might interrupt and interfere with, or constrain business operations and access to markets. On the opposite end, climate change also offers new business opportunities related to prevention and adaption.

All available evidence indicates that climate system changes lead not only to higher temperature, but also to an increase in extreme weather events of all possible kinds. Businesses will have to plan for and be prepared for more frequent and more extreme temperature events, including

- heat waves, potentially accompanied by droughts
- freezes, potentially accompanied by snow storms
- storms and torrential rains, potentially leading to floorings and land slides

In addition, the changing weather, air and water stream patterns might lead to changing rain patterns, both in terms of annual rain volume and distribution in time over the year. Combined with excessive use and pollution of natural aquifers and surface water, water shortages have to be expected in large parts of the globe, further affecting business operations.

Physical impacts and their consequences on business operations are summarised on the following page.



Climate change physics: operational implications

Climate event	Secondary events	Business implications	Opportunities
Heat-wave	• Draught • Wildfires • Desertification	• Water supply disruption leading to production disruption • Facility cooling costs • Lower system and operational efficiency in certain industries (electric grids)	• Intelligent monitoring systems • Intelligent irrigation • Water treatment and supply • Desalination
Freeze	• Blizzards	• Supply disruptions through transportation failure/disruption • Facility heating costs • Employee commuting difficulties -> production disruption	• Intelligent monitoring and emergency systems
Storms	• Biodiversity damage and loss (forests, agriculture)	• Physical damage to built facilities • Supply disruptions through transportation failure/disruption • Supply disruption through lack of raw materials and/or energy in certain industries • Delivery disruptions through transportation failure/disruption • Higher insurance policy costs • Employee commuting difficulties	• Intelligent monitoring and emergency systems • Construction
Excessive rain	• Spring floods, • Flooding • Landslides	• Physical damage to built facilities • Supply disruptions through transportation failure/disruption • Delivery disruptions through transportation failure/disruption • Higher insurance policy costs	• Intelligent monitoring and emergency systems
Rising average temperature	• Desertification • Pole cap melting • Rising sea levels • Increased desertification and saline intrusion • Permafrost thaw (increasing landslides in mountain regions)	• Disruption of access to markets • Disruption of supply • Physical damage to built facilities • Higher insurance policy costs • Market instability through potentially increasing social unrest	• Sustainable agriculture, irrigation and water desalination • Intelligent buildings & infrastructure

2.2 Climate change regulations

Climate change related regulations on a national or international could have a major impact on the way business manage their operations. However, implementation of regulations require political will and consensus. The absence of political will and consensus has resulted in the lack of to climate change regulation (other than mandatory reporting of GHG emissions in some countries

Mandatory reporting

Mandatory reporting requires a company to track and report GHG emissions – in other words, to fully track energy usage. Installation of an IT-based system with a central database to monitor energy usage is a marginal cost aspect for corporations. Analysing performance trends overtime and per facility allows for evaluating least-cost savings potential, (what gets measured gets done) and considering the cost implications of energy usage it is somewhat surprising that measuring and analysing energy usage has not been an internal standard procedure in many large companies until recently. Due to forcing business to track their performance (the basis to achieve reductions), mandatory reporting requirements have a net positive impact on the business bottom line

National regulation regarding GHG Caps or Cuts

Some countries have introduced mandatory caps for certain industries. Given that government always have the competitiveness of their respective economies in mind, it is highly unlikely that caps will have negative impacts on the corporate bottom-line. Respective schemes (e.g. in Korea) are aimed at forcing companies to reduce GHG emissions through realising the economically viable energy savings potential. Such schemes therefore have a net positive effect on the corporate bottom line through reducing energy-related costs.

International treaties and caps (Kyoto and post-Kyoto)

International treaties with the aim of introducing global mandatory caps could, in theory, require a nation to cap and eventually reduce its total greenhouse gas emissions. However, no government will ever be willing to accept a real or perceived threat to its economic competitiveness. In the political sphere, a "perceived" threat carries an much higher weight than a real threat, as the fruitless meeting rounds to find a post-Kyoto agreement have shown - mandatory national caps have been an illusion from the outset. In addition, setting caps and allowances within a country is extremely complex, would require a costly administrative overhead and probably could not be achieved in a truly fair and even way. It therefore can safely be assumed that national caps are highly unlikely to ever have a real and tangible impact on businesses.

2.3 Climate change economics

Climate economics

Climate change economics is simple – at least in theory: through taxing or allocating a value to GHG emissions. Another, albeit more complex approach are “market-based” instruments, such as the cap-and-trade systems proposed in the Kyoto Agreement.

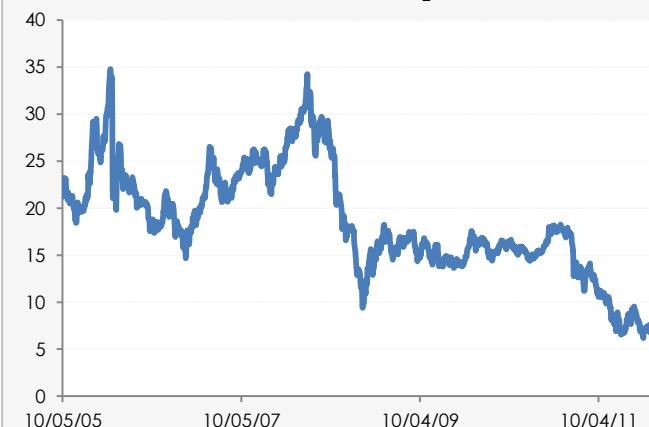
Market-based systems (cap & trade)

The cap and trade system theoretically agreed in Kyoto and partly implemented in Europe is a beautiful theoretical construct: reward the good, punish the bad. However, it is in the nature of theoretical constructs that practical implementation is not always straightforward. The definition of baseline years, organisational boundaries, “emission reductions, and “carbon sinks” are highly complex and often controversial. The allocation of allowances has created significant administrative overhead, and the complexity of calculations has led to huge loopholes – with close to zero net effect on actual emissions. The same applies for the CDM mechanism. A large percentage of emission reduction certification revenues are flowing to projects that are, at least, questionable (for example through emissions reduction certifications issued for the gasification of plant residues in palm tree plantation, providing additional incentives to burn pristine rainforests). In other words – the CDM has created wrong incentives. In the absence of an international post-Kyoto agreement, the carbon market has become nearly redundant, reflected in traded carbon prices, and will not have any tangible impact on businesses.

Carbon/GHG Tax

A carbon or GHG tax would be more simple than a cap-and-trade systems: allocating a value on GHG emissions. The value is added as a tax on the energy sources (and other GHG emissions sources) based on their GHG contents. Revenues generated through such a tax could be used to reduce other taxes on energy, or invested in projects of national strategic interest (e.g. a renewable energy infrastructure). However, in order to be effective and economically non-discriminatory, such a tax would have to be applied globally, or in all countries at the same level, thus making energy intensive products more expensive at a global level and providing incentives to reduce energy intensity. If applied globally, such a tax would affect cost structure of certain industries, but not affect the overall competitiveness of whole industry sectors. However, while there are some lonely voices campaigning for an abolishment of the cap-and-trade system in favour of a GHG tax, such discussion have never been picked up in international meetings. The lack of political will seems to make the easiest and most logical economic solution to climate change impossible.

Traded Carbon Price per ton CO₂e, 2005-2012



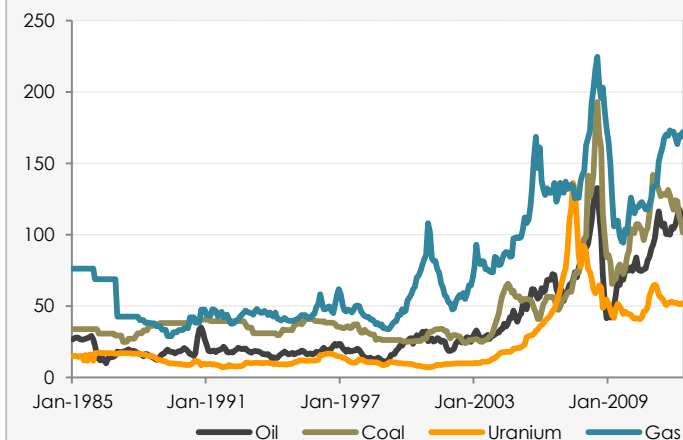
Price of traded carbon reductions have dropped significantly, reflecting failure of “market-based” instruments

Consumers & climate change economics

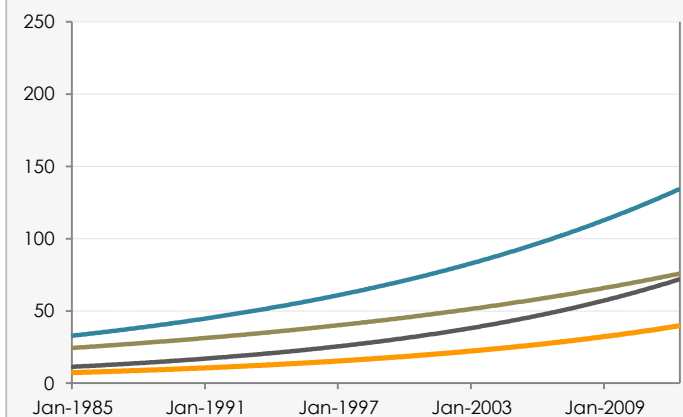
Consumer choices are significant market (economic) drivers. Climate change and its potential impact are now known across the globe. However, consumer's choices seem to be nearly unaffected by that knowledge: despite significantly higher GHG emissions, the vast majority of consumers still prefer large and heavy cars given the choice and affordability. In the B2C sphere, climate change does not significantly alter consumer choices and therefore remains a niche market (the Toyota Prius, for example). However, higher energy costs (i.e. tangible impacts) have an immediate impact on consumer choices.

Energy cost development

Fossil energy prices, 1985-2012



Normalised trend of fossil energy price, 1985-2012



Today's industry has been built on the cheap and easily accessible and transportable fossil fuels. While energy usage globally has increased, no new easy accessible and exploitable fossil resources have been found. There are still fossil resources available, but exploitation of non-conventional sources – deep sea, tar sands, arctic, etc. are far more expensive to extract than deposits close to the surface in easy accessible regions (e.g. Saudi Arabia). As a consequence of increased demand and lower cheap supply, global oil prices have witnessed a significant price hike over the past 10 years. Spot prices of fossil fuels – oil, gas, coal – and uranium are interlinked and show near-identical trends. While most analysts agree that future energy prices and cost increase are highly likely, there is a large number of uncertainties or unknowns that influence future fossil energy costs:

- The amount of remaining fossil reserves ("peak oil", a highly controversial issue), including uranium
- Technology and cost developments for exploiting "unconventional" fossil resources (ultra-deep sea, tar sands, shale gas, arctic deep sea, etc.)
- Economic growth
- Government policies in terms of incentives, direct & hidden subsidies (tax breaks, direct funding, military expenditures aimed at controlling fossil resources)
- The shift of geopolitical power from West to East and geopolitical developments and interventions

The cost of energy is dependent on both demand and supply. Supply is driven by availability of oil and existence of economically viable alternatives (gas, coal, uranium). Renewable energy has the potential to become an economically viable alternative in the near future given sufficient capital allocation that would allow for economics of scale. Given that exploration costs for fossil fuels are rising, the future end-user energy costs will be influenced by the advancement of renewable energies, which in turn depend on

- Cost development of renewable energy technologies (solar, wind, wave & tidal, small-scale hydro, reactor bio-fuels, etc.)
- Volume and strategic allocation of capital investments, both public and private, for energy sources, technology, and development of projects

Different energy sources and energy technologies (and the respective economic players behind sources/technology) are competing (and lobbying) for private and public capital. Predicting future energy costs depends on a large number of inter-acting factors, government policies, technology breakthroughs, and capital investment allocation.

Regardless of the outcome of policies and capital investment allocation, rising energy costs will have an increasing and significant bottom-line impact on businesses.

2.4 energy and the business bottom-line

Energy costs to businesses

The energy question directly affects the bottom-line of companies: energy needs to be purchased for operating facilities, machinery, offices, and transportation of goods. Depending on the industry, cost for purchasing energy – primary energy or a electricity – can be a considerable cost factor, regardless of climate change and relevant regulation.

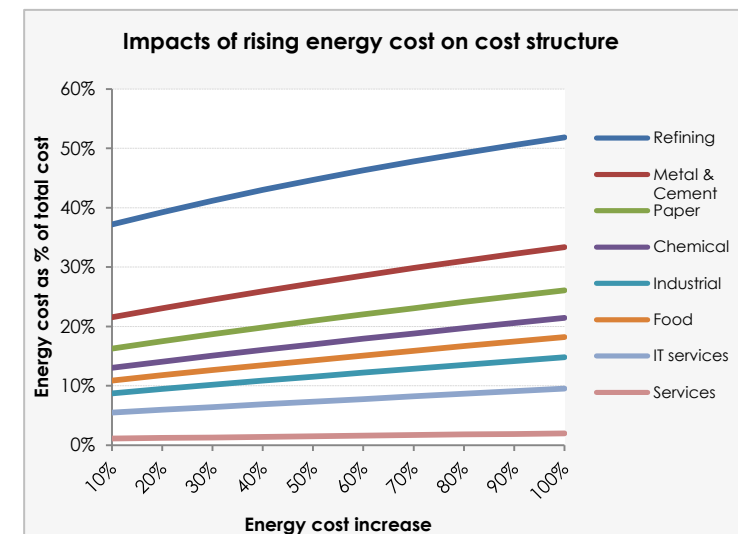
Bottom-line impacts of rising energy costs

With global energy prices on the rise as witnessed over recent years, the impact on corporate's bottom line has increased accordingly. Significant energy cost increase could potentially wipe out the total current profit rate in energy-intensive industries (see graphs). Because all industries of a sector are facing the same cost increase, some of these costs will be passed on to customers. However, increasing operational energy efficiency, in particular in energy intensive sectors – has become an aspect of competitive advantage,

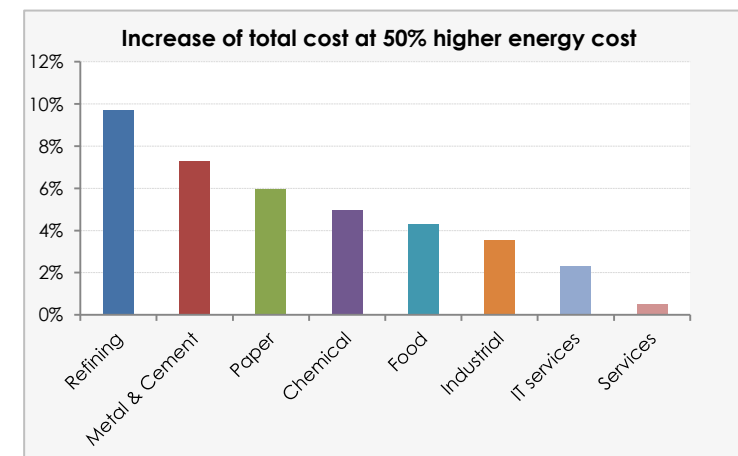
With rising energy costs, energy cost and energy efficiency will have a significant bottom-line impact that cannot be neglected in most industry sectors other than the purely serviced-based industries.

New business opportunities

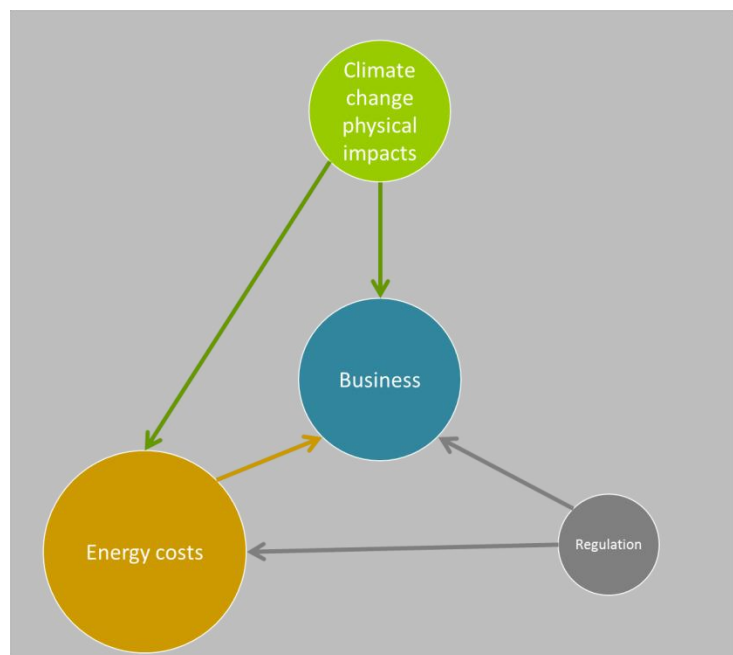
At the same time, the need for higher energy efficiency and new technologies is creating immense new business opportunities in relation to energy efficiency of products, energy efficiency services, intelligent control and remote control services, renewable energy technologies, and innovative new business models related to energy management.



Impacts on cost as function of rise in end-user energy prices in selected industry sectors



2.5 Connecting the dots



The climate-energy-nexus. Energy costs are expected to have the highest direct bottom-line impact, while regulatory changes are expected to be limited.

Energy cost the overarching concern

Climate change, climate and energy regulation, and energy cost all have increasing tangible and intangible bottom-line impacts on businesses. However, rising energy costs have the most immediate and tangible impacts on businesses.

Climate change regulations

Given the lack of political will and global consensus, it can safely be assumed that a global climate change regulations is not a realistic scenario. In the absence of an internationally binding global agreement of GHG reductions, no government will move towards a perceived confinement of the competitiveness of its industry and economy. Some countries have introduced mandatory GHG inventory accounting and /or reporting legislation, and more are likely to follow. Implementing accounting systems is not a cost factor for companies. On the contrary – data series allow companies to recognise and capitalise energy efficiency and cost savings potential, increasing competitiveness. Given the lack of vision, leadership and global consensus, it can safely be assumed that **climate change regulations bottom-line impacts on businesses around the globe will remain negligible.**

Climate change

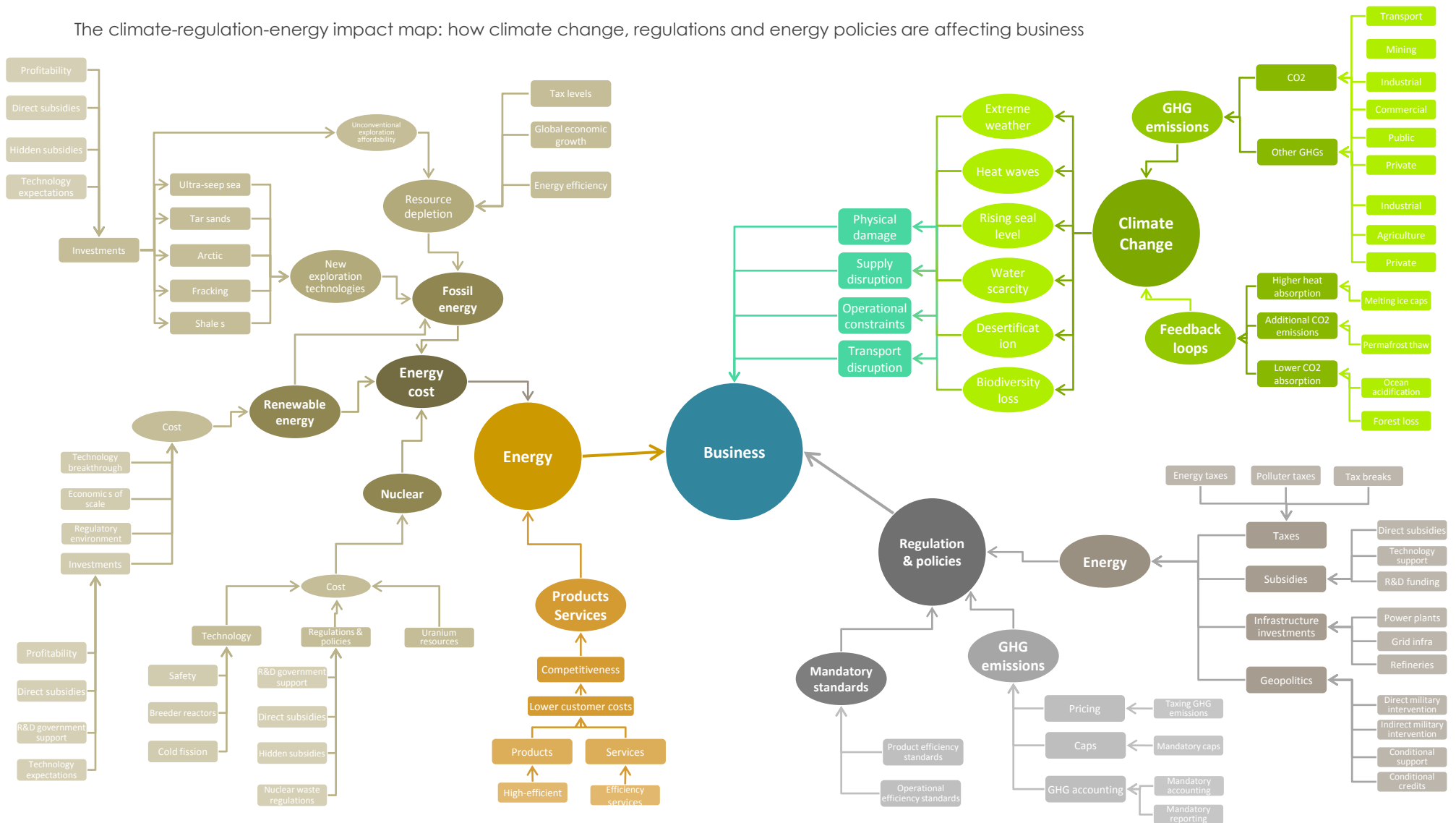
All empiric data collected over recent decades imply that events of extreme weather will continue to rise. **Physical damage to facilities and disruption of supply, operations, and access to markets have therefore to be expected.** However, given the complexity of the climate systems, graveness and time of the tangible impacts of climate change cannot be predicted in detail. The only thing that is sure is that nothing is for sure. In other words – climate change induced **predictability and stability is emerging as a business threat.**

The energy question

Spot-prices for fossil energy and nuclear fuel have risen steeply over the past decade, and resource availability indicators coupled with rising demands from emerging economies and market expectations are leading to continued future price hikes in the absence of viable large-scale alternatives. **Energy costs as percentage of overall costs will therefore significantly ascent, seriously affecting business bottom-lines.**

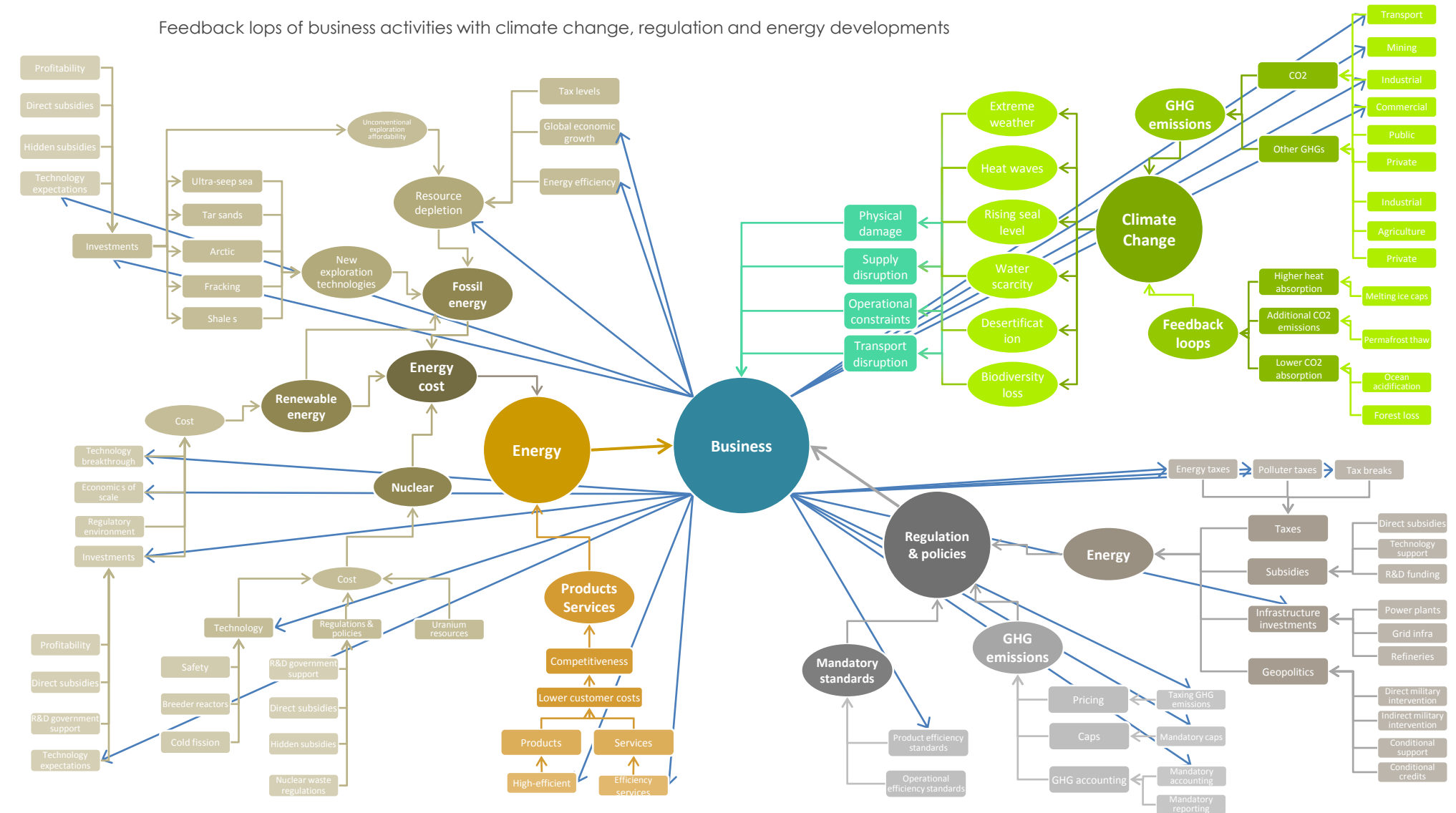
Climate-energy business map

The climate-regulation-energy impact map: how climate change, regulations and energy policies are affecting business



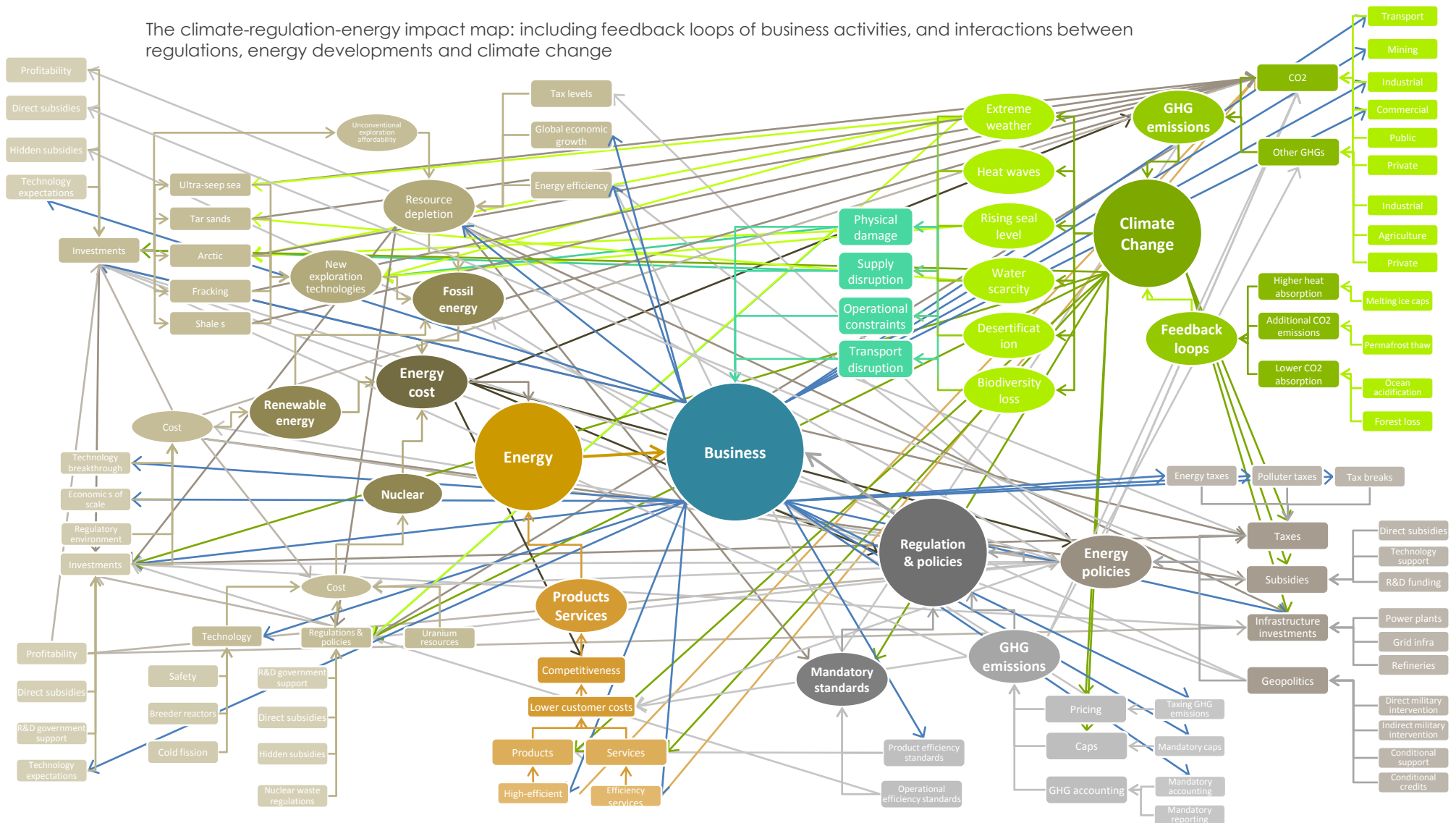
Climate-energy business map

Feedback loops of business activities with climate change, regulation and energy developments



Climate-energy business map

The climate-regulation-energy impact map: including feedback loops of business activities, and interactions between regulations, energy developments and climate change





climate change,
energy,
& businesses



3

three scenarios

3. The scenarios

Businesses will continue to operate regardless of the future environment. However, the development and strategic priorities are directed by the environment businesses operate in. The environment is driven by the regulatory environment, cost factors, available choices, and market expectations. In order to assess the business impacts of the climate change – energy nexus, it is necessary to make certain assumption about key future developments related to these issues. The impact analysis on different industry sectors in this report are based on comparison between three potential future scenarios. The three scenarios are:

BAU (Business As Usual)

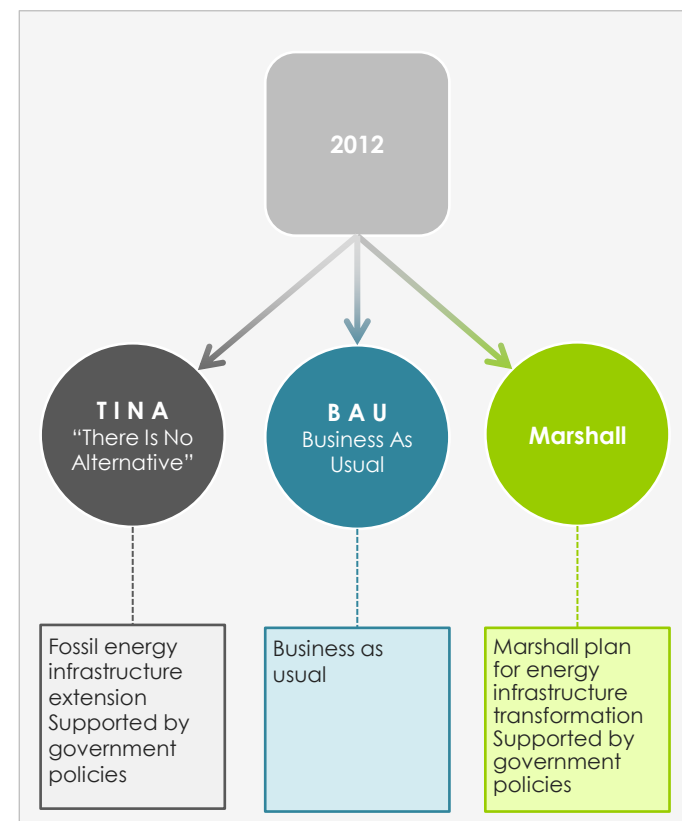
As the name suggests, this scenario assumes that business continues as usual as we know it – i.e. the world is driven by the markets, with minimal interference, guidance or leadership on the part of elected or unelected state authorities or international organisations. Business-as-usual also implies that the business environment continues to lack any form of democratic legitimisation. However, the scenario assumes that the financial crises can be resolved within a reasonable time-frame to free resources to address the real economic issues.

Marshall

The Marshall Scenario is named after the Marshall Plan executed to rebuild Europe after World War II. The scenario assumes that - individually and/or under the umbrella of international organisations - governments will design a Marshall plan for the climate-energy question, with a strategic re-allocation of investments to develop large-scale renewable energy infrastructure. It also assumes the real economy is freed from the constraints imposed by the financial markets, and that the finance industry is regulated according to its gambling and speculative nature. It also assumes that key decisions are democratically legitimated through referenda. Today's technology allows for easy and cost-effective voting, and there is no reason why "democracy" should be limited to a choice between two equally untrustworthy candidates every few years that cannot be held accountable and whose main functions seems to be representing their respective country in meaningless and costly summits.

TINA (There Is No Alternative)

The TINA scenario is based on the "there is no alternative" ideology that was promoted since the 1980s, under which ideological free-market pureness is more important than economic reality and sometimes leads to irrational decision making. Unfortunately, there is indication that seems to imply the World (in particular Europe, but also the US) is heading towards a "TINA" scenario.



Scenario overview; elements

Issue	BAU	Marshall	TINA
International agreements	Governments keep meeting at climate summits without tangible outcomes. Emission trading remains voluntary and keeps diminishing in importance	A shared vision of the future is defined. However, binding GHG reduction targets for each country remain an illusion. Emission trading is abandoned in favour of national energy taxes.	Governments keep meeting at climate summits without tangible outcomes. Emission trading keeps diminishing in importance and will eventually completely disappear.
National climate policies	GHG accounting becomes mandatory over the years in more and more countries, lagging behind corporate reality where accounting is becoming a cost factors. Emission trading schemes keep existing in a negligible form.	GHG accounting and reporting throughout the value chain becomes standard around the World through automatised IT-based accounting systems. The GHG protocol is expanded for better accounting of supply chain and life-time GHG emissions and energy usage Some countries implement GHG regulations and GHG taxes	GHG emissions are considered a market issue, and considered voluntarily. However, businesses will implement energy accounting systems to control increasing costs as a consequence of rising energy prices.
Climate change	Climate change effects are becoming more real through slowly rising temperatures, but mostly through increased frequency of weather extremes, particularly after 2020. GHG emissions are expected to peak in 2025, but time delay in the climate systems lead to accelerating trends of extreme weather until 2040, causing serious damage to infrastructure and interrupting market flows.	Climate change effects are becoming more real through slowly rising temperatures, but mostly through increased frequency of weather extremes, particularly after 2020. Global GHG emission are starting to fall between 2015-2020, but due time-lags in the climate systems, climate change effects will not start to subsidise before 2040.	Climate change effects are becoming more real through slowly rising temperatures, but mostly through increased frequency of weather extremes (heat waves followed by storms torrential rain and spring floods; landslides; tropical storms, freak winters) until 2020. Increasing GHG emissions and feedback loops will greatly accelerate this trend thereafter, causing major damage to infrastructure and interrupting market flows.
National energy policies	Due to concerns over rising energy cost, most countries implement some sort of energy roadmaps. However, even increased allocation for renewable technologies remains insignificant in relation to investments in fossil and nuclear infrastructure and subsidies (direct and hidden subsidies). The lack of a coherent energy strategy and lack of tackling direct and hidden subsidies for conventional (fossil & nuclear) energy sources and energy companies keep distorting the market until deep into the 2020s.	National energy marshal plans pushing renewable energy technologies specific to countries characteristics are designed and implemented before 2015 in major economies. The plans set technology priorities and allocate significant public re-directs funds, subsidies and tax-breaks for the development of renewable energy technology and power plants.	Only a few countries implement more than vocal plans. Energy security and technology developments are dealt with through the invisible hands of the markets.

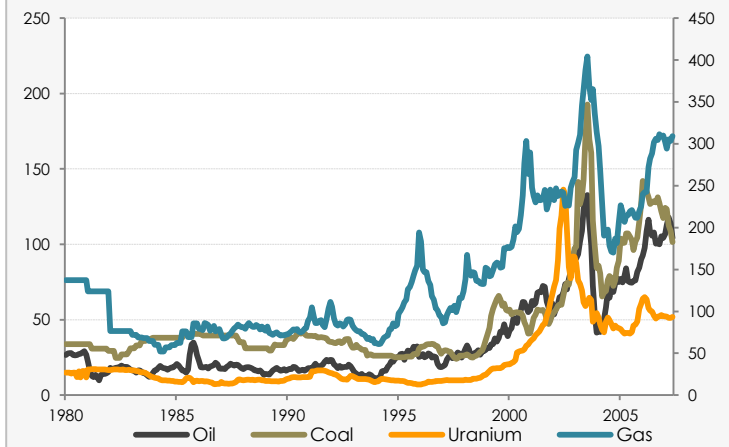


Scenario elements

Issue	BAU	Marshall	TINA
Energy technologies	Renewable energy technologies are gaining economic competitiveness driven by private capital as fossil sources are becoming more expensive. By the mid 2020s, renewable energy technologies are becoming economically viable, and states will slowly start funding large-scale renewable energy projects, further accelerating technology and efficiency gains in renewable energy.	Renewable electricity will become significantly cheaper and economically viable between 2015 and 2020 due to public and private investments for R&D and project development as well as economic of scale based on e renewable energy Marshall plan. Storing electricity through transforming to hydrogen or by other means will become economically viable by 2030.	The lack of a coherent energy strategy leads to significant resources channelled to securing and exploiting conventional energy sources (fossil & nuclear), delaying the advancement of alternative technologies. However, increasing energy prices will make renewable energy technologies more competitive by the end of 2020s.
Private and public investments	Private capital flows to renewable energy technology will only start flowing in significant volumes when technologies have matured and are economically viable, which cannot be expected before 2025 under the BAU scenario. Limited public capital is available for demonstration projects and the development of already viable technologies (wind energy).	Public capital and investments serve as seed money to make renewable technology rapidly competitiveness. Due to a combination of a clear energy roadmap and public investments, private capital is being allocated in significant amounts to renewable projects starting no later than 2015.	Private capital will only flow into renewable energy in meaningful volumes when economic viability is reached, i.e. when fossil energy becomes prohibitively expensive. Direct and hidden subsidies for fossil sources are not tackled and keep distorting the market against renewables, further delaying private investments in renewables.
The financial crisis	Business-as-usual: politicians continue to apply first-aid strategy without addressing root causes. Minor stimulus programs might be adapted, but significant resources remain clogged for dealing with emergency measurements. Europe and North America remain in recessions until the mid-2020s.	The financial crisis is tackled on the root – through regulation of the financial industry in order to free governments from the stranglehold of “the markets”. Coupled with meaningful stimulus measurements and economic policies that foster the lost manufacturing industry, the global economy will start a sustainable recovery starting late 2013.	There is no alternative: austerity measurements continue without economic stimulus in key European countries and the US, dragging the World economy in a serious recession and/or depression lasting into the 2020s.
Financial industry	Continuous scandals will force politicians to apply minor changes to financial regulations without tackling the root cause. Governments will remain dependent on market developments, and credit for the real economy remains scarce.	Re-enforcement of the Glass-Steagall Act, separating the credit and banking industry from the gambling industry, eliminating the “too big to fail” problem. Stronger regulation of high-risk derivative financial products and commodity speculation.	There is no alternative. Financial markets remain completely unregulated, keeping governments dependent on market developments and causing serious shortness of credit availability for the real (producing) economy
Democratic legitimization	Politics continues as usual, with unaccountable politicians making decisions for the population of their respective countries. Democratic legitimization of key decisions remains non-existent	Internet and communication technology is used to conduct national referenda on key strategic issues, making future developments democratically legitimated through direct democracy means.	Due to extreme developments, increased social unrest is expected under this scenario, leading to a further polarisation of the politics, and strategic decisions or non-decisions remain illegitimated.

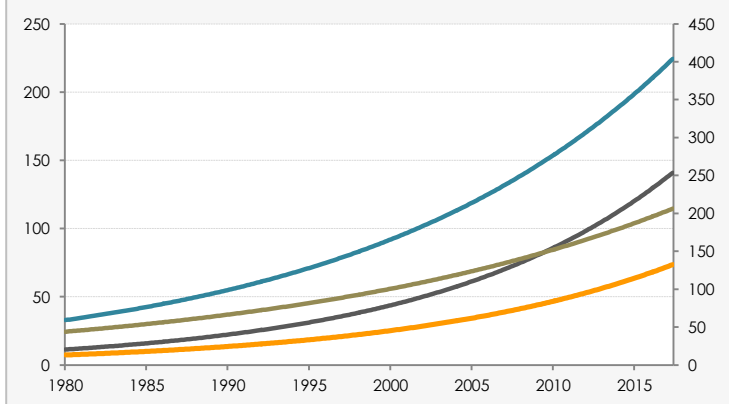
Energy cost developments

Fossil & nuclear energy prices, 1985-2012



Energy spot prices 1980-2012. Source: IMF

Normalised continuous trend, 1985-2022



Past developments: heavy depending on the oil price

Due to high energy density, transportability, and relative safety, oil has become the energy source of choice. End-user energy prices throughout the 20th century to this day have been driven by the spot price of oil. Due to the over-arching importance of oil for the economy, other fossil fuels AND the price of uranium (nuclear fuel) are strongly tied to the oil price, as the comparison of the prices for oil, gas, coal and uranium over time clearly shows. The oil price itself is driven by a number of factors:

- **Demand:** demand is driven by economic growth, particular in the emerging economies. Growth in the "mature" economies triggers only modest increased due to the higher focus on service industry and developed infrastructure. People coming out of poverty starting to use cars, air-con etc. and the development of industry and infrastructure in emerging economies triggers higher demand. Demand is expected to keep growing in line with growth in the emerging economies under a business-as-usual scenario
- **Supply:** supply depends on the availability of resources. Some analysts have warned of peak-oil for years, and the recent turn-around of the traditionally conservative International Energy Agency (IEA), warning of potential supply shortages is convincing evidence that cheap and easily available resources are starting to decline. Future oil supply availability depends on technology advancements and capital investment in non-conventional sources, such as tar sands, deep-sea drilling, arctic exploration, gas fracking, etc. However, these exploration technologies require a high per-barrel price to be economically viable, and are competing for capital with renewable energy.
- **Geo-political tensions:** armed conflicts and insurgencies in key oil states have an immediate effect on global oil prices. A closure of the Strait of Hormuz or other key transport routes due to conflicts could have serious impacts on supply and prices. Targeted sabotage on key facilities, e.g. on Saudi Arabia's main oil port of Ras Tanura, could have similar effects
- **Markets expectations and commodity speculation:** expectation of future growth, demand and supply as well as commodity trading and speculation have significant impacts on short-term fluctuations of the oil price, as the spikes in the oil-price charts clearly indicate.

Future price developments

If the past 30 years are an indicator, the oil price – and with it, prices for gas, coal and uranium – are set to increase further. If the trend over the past 30 years would be to continue linearly, the oil price would increase to 145 \$/barrel in 2022, a significant increase over current prices under a business-as-usual scenario. However, normalising trends do not take into account supply availability, technology developments, and competition by other energy sources and technologies.

Energy technologies: competition for capital

Different technologies and resource companies are competing for capital (and subsidies)

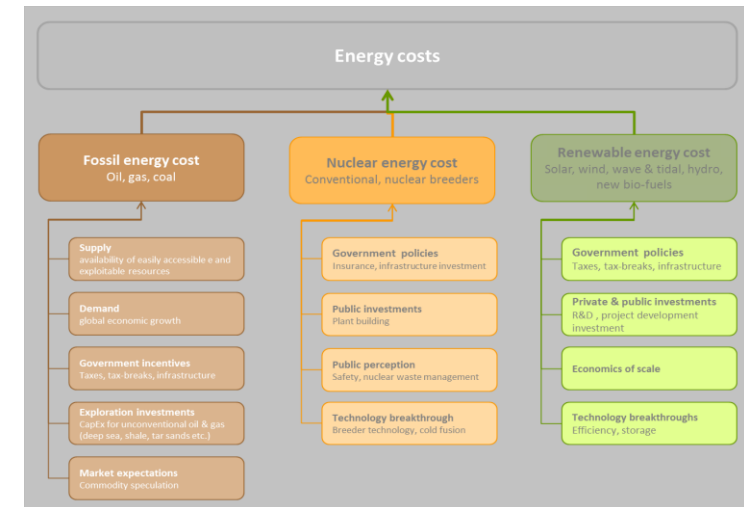
Energy demand is set to further increase in the future with economic and population growth. The prospect for profit and return on investment will accordingly direct capital towards energy resource exploitation and energy technologies. In a capitalist World, investors and capital owners are directing their investments towards ventures and projects that they see as most profitable and secured return of investment. In an absolute free and undistorted market with complete information, this is a straightforward decision. However, markets are distorted in various ways (regulations, subsidies, tax breaks, indirect subsidies, etc.), and because the future is not known, information is always incomplete.

Private capital flows where it expects profit. The energy equation is to a large extent influenced by subsidies, taxes, tax breaks, provision of infrastructure, investment guarantees, hidden subsidies and military expenses aimed at protecting resources and the transportation of resources. If the cost of the military invention in Iraq were to be added to the price of oil, the cost of fuel would be far higher. At the heart of what decides over profitability and economic viability of energy sources and energy technologies therefore lie state policies and interventions.

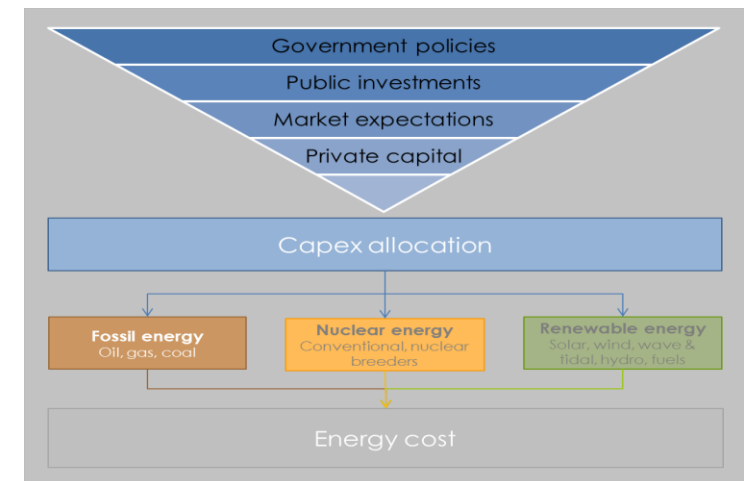
Governments are setting the strategic energy policies and development direction. By setting tax levels on energy (and possible GHG emissions), providing tax breaks, funding of infrastructure, granting exploration or generation licenses, formulating environmental regulations, building or providing funds for power plant construction (conventional or renewable), funding research programs and regulating tariff schemes, governments have a set of very powerful tools at their disposal to influence the future energy infrastructure at their disposal. If a national energy strategy is defined, influencing the balance between the different players, resources and technologies, the private capital will follow – because private capital always flows to where a return on investment can be expected. While an energy Marshall plan might somewhat increase energy costs to businesses over a short period of time, the current business-as-usual approach will significantly increase business energy cost in the mid-to long term.

Governments define the energy future even if they do not formulate a national energy strategy. Not formulating a national energy vision or strategy is equal to business-as-usual where future energy development is left to “the market”, i.e. the most powerful players on the market.

There is currently no evidence that governments are willing to use the tools at their disposals to the full extent. Minor programs and vague commitments to goals far in the future (that leave the actual implementation to political successors or future generations) do not significantly alter the energy equation.

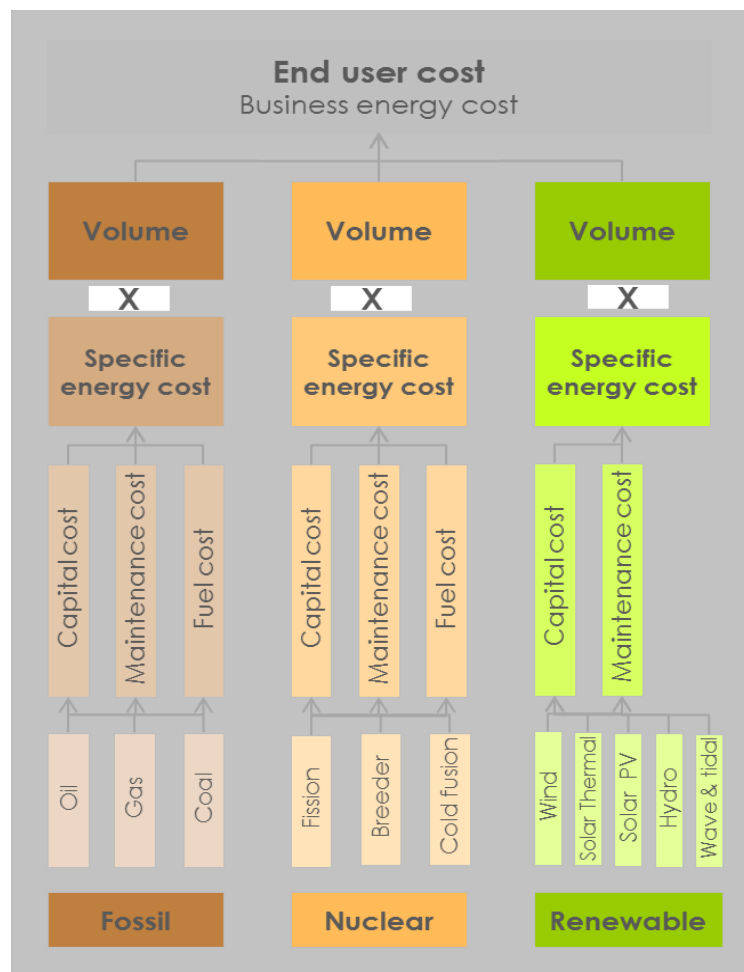


Drivers of end-user energy prices (operational energy costs to businesses)



Drivers of future cost of different energy sources and technologies

Scenario calculation: energy cost to businesses



Composition of energy costs to businesses

Energy businesses take an active interest in energy technologies and resources. For all other industries, energy is a service that they pay for. They do not care about the source of the primary energy or technologies applied to generate the electricity required to operate as long as stable energy supply is guaranteed. For business, energy is primarily a cost factor. As a counter-measure to increasing energy costs, businesses have started to analyse their energy usage in detail to identify energy consumption reduction potential with the aim of reduce operating costs.

While the oil price – normally measured in US\$ per barrel of oil – is the common indicator for energy costs, the oil price is not a good measurement to quantify end-user energy costs. Business have to pay bills for MWh of electricity, cubic meters of gas, or tones of oil. In order to measure the overall energy cost to businesses, it is therefore necessary to find an inclusive energy cost measurement to analyse energy costs impacts across all energy usage.

The end user energy cost is based on a mix of the cost of the different primary energy sources (fossil, nuclear, renewable) and generation/conversion technologies (thermal, fissile, renewable). For the purpose of this analysis, the average cost of a MWh of end user energy is calculated by multiplying the volume and costs of primary energy sources with the respective generation/conversion costs. This calculation has been conducted to predict average future energy costs to 2040 for the three different scenarios (BAU ("business-as-usual"), Marshall, and TINA ("there is no alternative")).

About scenario calculations

Predictions of the future are not exactly an exact science. While it is possible to calculate and assign eventualities factors for certain events based on the circumstances, scenario calculations cannot take into account all eventualities and factors to predict the future. In order to analyse and forecast the future energy costs, a wide range of assumption about future developments have to be made. Different assumptions lead to different scenarios. Making assumptions is based on past and present development, and includes known and "known unknowns". In addition, the future could also contain "unknown unknowns". The analytical framework used to calculate future values therefore cannot and does not pretend to withstand scientific scrutiny and make exact predictions. The calculated values aim to highlight impacts of strategic policy decisions (including decisions not taken) and their possible impacts on businesses under different future development scenarios.

Sustaining business competitiveness

Government policies and business readiness

Regardless of the nature of national (and/or international) policies chosen and roadmaps followed by governments and state authorities regarding energy and climate change, businesses need to have strategic answers formulated and ready to implement.

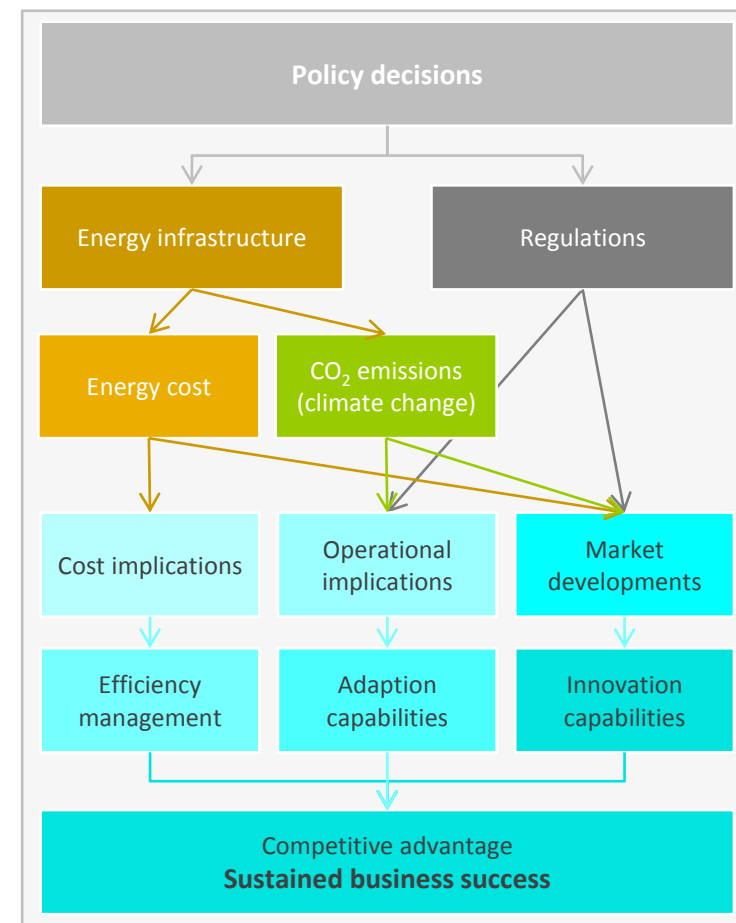
Government decisions AND non-decisions (i.e. a business-as-usual approach or there-is-no-alternative approach) towards energy infrastructure roadmap and climate change have implications on businesses:

- Energy infrastructure policies are guided by government initiatives. The nature of infrastructure roadmap is heavily influencing future energy costs, and creates business opportunities in new industry sectors. However, different industry sectors (renewable industry vs. fossil/coal industry) are competing for favourable conditions and capital (public and private) and are therefore trying to influence policy decision through lobbying.
- Energy taxes: taxes on energy have a significant impact on cost structure. Empiric evidence indicates that industries in countries with higher energy taxes (e.g. Japan) have achieved higher energy efficiency and are therefore in a better initial position to deal with rising energy cost.
- Energy tariffs: electricity tariff structure are regulated in most countries. All kinds of tariff structures are currently applied in different countries – progressive (the higher the consumption, the higher the price per unit), linear (fixed price per unit), and regressive structures (the higher the consumption the lower the price per unit). Changes to tariff structures have direct cost implications to businesses, especially in countries used to a regressive tariff structure.
- Mandatory efficiency standards: government authorities can implement mandatory efficiency standards, requiring businesses to improve their products
- Governments also have the power to tax emissions and pollution, or cap emissions

Government policies following the BAU or TINA approach have medium/long- rather than short-term impacts. Lack of meaningful long-term energy planning and timely investments in alternatives on the required scale will lead to rising energy cost mid-term, and climate change impacts will also be stronger in the longer term.

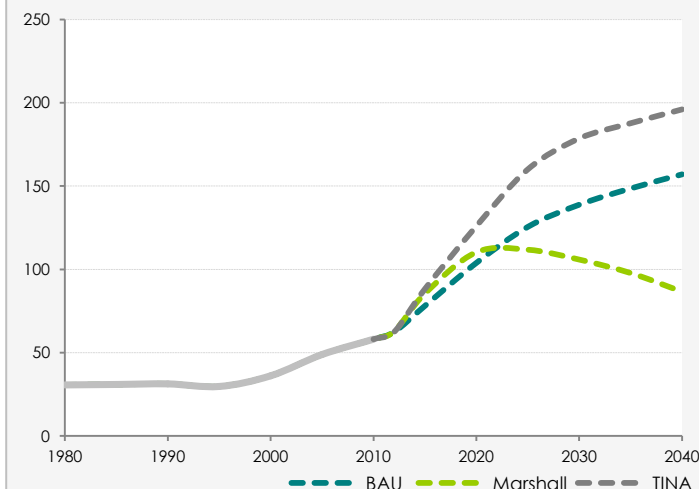
Marshall scenario policies have a lower immediate impact, but will lead to lower negative impact on business operations, cost and revenues than BAU and TINA scenario policies.

Whatever policies are eventually chosen, businesses need to be prepared for implications in order to sustain competitive advantage in the changing environment



Future energy costs under the three scenarios

Future end-user energy cost development (\$/MWh)



The recent development of rising energy costs is continuing under all three scenarios. However, timeframe and level of end-user energy cost per MWh of energy consumed is distinctively different for all scenarios.

BAU

End-user energy cost is slightly lower until 2015-2017 under the BAU as compared to the Marshall scenario. The difference between the BAU and Marshall scenarios until 2020 is marginal and most likely within error margin. However, the lack of timely large-scale investment in alternative energy infrastructure will lead to higher end-user energy costs when the remaining fossil resources – in particular oil – becomes more difficult and costly to extract starting post 2015, a trend that will continue into the 2030s in the absence of a concentrated energy infrastructure long-term plan.

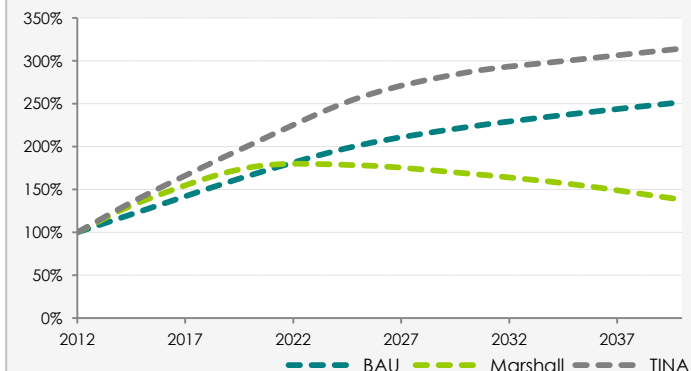
Marshall

The flow of capital from fossil exploration towards the development of renewable energy capacities is influencing market sentiments through fears of oil supply shortages and influence market sentiment, negatively affecting short-term oil prices until 2015-2017. Post 2020, the economic of scale effect and the commissioning of large renewable generation capacity starts to kick in, and end-user energy costs will start to decrease following a peak around 2020. Ironically, the availability of renewable energies also ease pressure on fossils energy demand, thus driving down the price of oil, gas and coal, further accelerated by lower incentives for fossil energy commodity trading and speculation. The combination of cheaper renewable technology and electricity with eased pressure on fossil energy demand leads to significantly lower end-user energy costs compared to both the BAU and TINA scenario post 2020.

TINA

Due to the complete absence of state direction, increasing demand and credit difficulties following the financial crises, energy end-user cost nearly double by 2020. The absence of meaningful, large-scale investment in alternative energy infrastructure is leading to supply limitations. Coupled with negative market sentiments and increasing commodity trading and speculation, end-user energy cost will further rise thereafter.

Energy cost development (% of 2012 value)



Energy usage and energy related CO₂ emissions

Global energy consumption

Energy consumption is a function of population size, economic activity (the characteristics of the industry, and the balance between agriculture, manufacturing industry and service industry), and last but not least, energy efficiency. Assumed that both population and the global economy keep growing, the total global energy consumption will further increase for some time under all three scenarios. Energy efficiency in turn is a function of cost and incentives. With rising energy cost, energy efficiency will gradually improve. It therefore can be expected that the population and economic growth will be decoupled from energy consumption increase at some point in the future. However, in the absence of other incentives (taxes, mandatory efficiency standards, education, R&D funding, economics of scale), energy efficiency improvements - and therefore the decoupling of growth and energy consumption - will be delayed. The decoupling of growth and energy consumption therefore depends on national and/or global policy interventions.

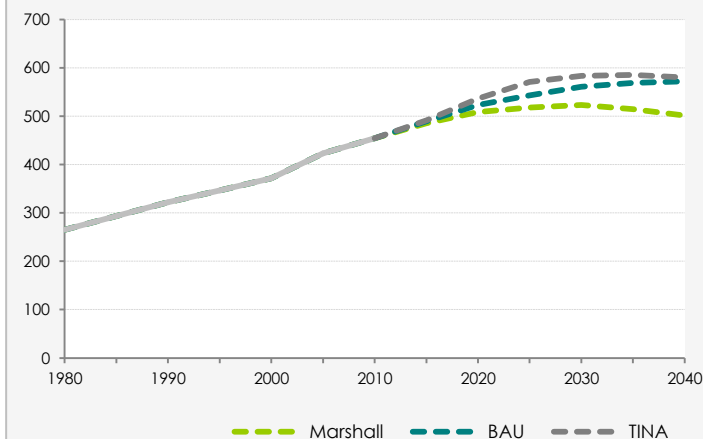
Under the Marshall scenario, the point of decoupling and declining global energy consumption point will be reached around 2025, with global energy consumption slowly declining thereafter. Under the BAU scenario, the decoupling will occur after 2030. Under the TINA scenario, prohibitive high end-user energy costs will force businesses to invest more in energy efficiency, and the decoupling will be reached at around the same time due to cost pressure.

CO₂ emissions from energy usage

Energy usage is the major contribution to GHG emissions. For the purpose of this analysis, only GHG emissions generated from energy extraction, electricity generation, and energy consumption is considered, i.e. excluding methane emissions from agricultural activities and GHG emissions from chemical compounds, such as used for refrigeration.

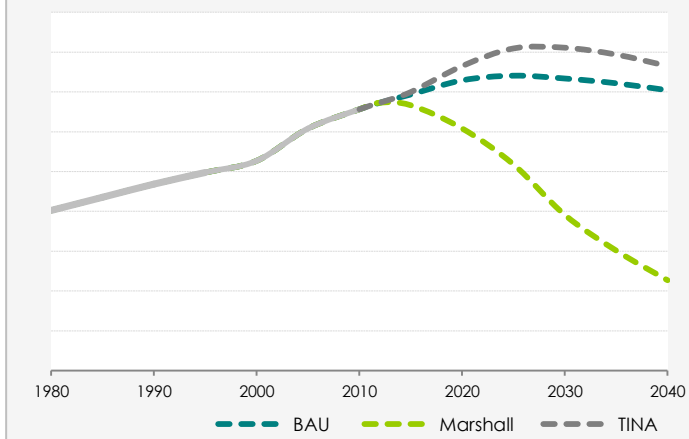
Energy related CO₂ emissions are composed of emissions of extraction of primary energy (oil, gas, coal, uranium), transport, conversion (refining, electricity generating), infrastructure development and maintenance, as well as end-user consumption. Renewable energy emissions consist of infrastructure development and maintenance. They are not completely emission-free but generate only negligible emissions compared to fossil based energy. Under the Marshall scenario focussing on the development of cost-effective renewable generation capacities, CO₂ emissions peak between 2015-2017 and start to decline steeply thereafter following the energy infrastructure transformation. Under the BAU scenario, renewable energy technologies will only start to play a significant role post 2030, with CO₂ emissions declining thereafter. Under the TINA scenario, CO₂ emissions will rise steeper until 2030, when the prohibitively high fossil energy cost will push renewables into economic viability.

Global energy consumption (quadrillions of btu)



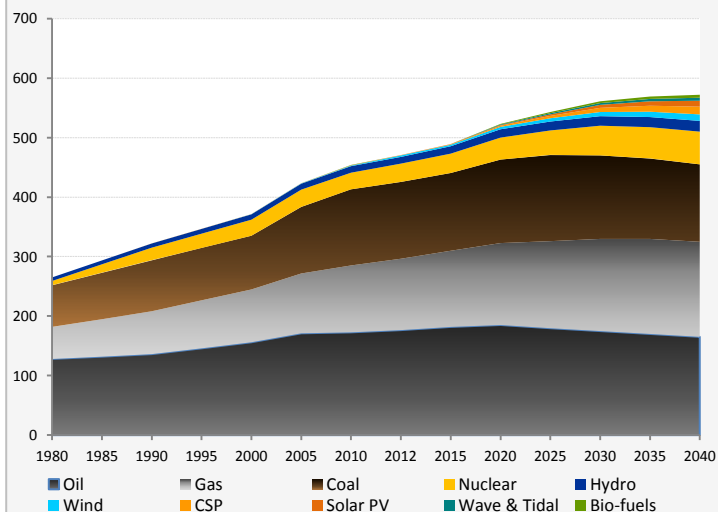
Sources to 2012: Exxon, BP, IMF, World Bank. Scenario calculation: SolAbility

Energy-related CO₂ emissions

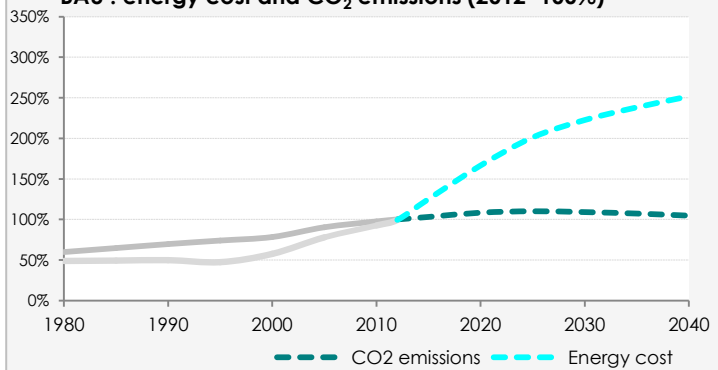


BAU - business as usual

BAU Scenario: energy mix



BAU : energy cost and CO₂ emissions (2012=100%)



BAU: the energy mix

The energy infrastructure and energy mix is driven by market forces (and maybe more importantly, market expectations). The energy mix will therefore not see significant changes until fossil energy becomes significantly more expensive due to demand-supply imbalance and the increasing capital and extraction cost to exploit unconventional resources (deep sea, arctic, tar sands, shales, fracking) required to satisfy increasing demand. In addition, the small supply surplus as compared to increasing demand will spur market fears, and increase short-term commodity speculation, further increasing spot-prices for primary fossil energy carriers.

Nuclear power generation is expected to increase as an alternative to guaranteeing energy security, particular in emerging economies of the East.

While wind power and PV maintain their growth, renewable electricity generation will only start to kick in measurable volumes (relative to global energy consumption) when it becomes economically viable against fossil energy, which remains heavily subsidised through indirect and hidden subsidies (taxing, tax breaks, public infrastructure provision, logistic support). The market distortions lead to a delayed economic break-even point for large-scale renewable infrastructure, which is therefore not expected to happen before 2025.

Energy-related CO₂ emissions

Energy-related CO₂ emissions under the BAU scenario are expected to further increase in line with economic growth, population growth, and increased energy usage. A decoupling of global energy usage and related CO₂ emissions is expected to start in the 2020s, with CO₂ emissions plateauing in 2025 and slowly decreasing after 2030. However, emissions levels will not reach pre-2012 levels before the 2040s, accelerating climate change for a long period.

Energy costs

Energy cost will keep rising in line with economic and population growth. However, continued pressure on supply driven by demand and the lower margin between demand and supply as well as related commodity speculation lead to steeper energy cost relative to economic and population growth. The lack of timely investment in large-scale alternative infrastructure and generation capacities will further increase pressure on prices, which is only easing off when renewable generation becomes economically viable against significantly subsidised fossil energy carriers after 2030. Businesses need to prepare and formulate strategic answers to increasing energy costs.

Marshall

Marshall: the energy mix

The energy infrastructure and energy mix is driven by integrated and comprehensive national energy infrastructure transformation plans, directing significant public funds towards utility-scale renewable generation projects, in particular wind power, concentrated solar thermal power plants, and ocean (wave, tidal) electricity farms. Combined with a reviewed tax and hidden subsidies approach, the large scale investment and economics of scale have a rapid impact on the economic viability of renewable electricity generation. The subsequent perspective of return on investment is attracting large private capital and investment, which further drives down costs, accelerating the transformation. By 2035, nearly 50% of the global energy consumption is covered by renewables under this scenario. Due to decreased demand and thus lower pressure on the supply of fossil energy resources, spot prices for fossil energy are also lower after 2020 compared to the BAU and TINA scenarios

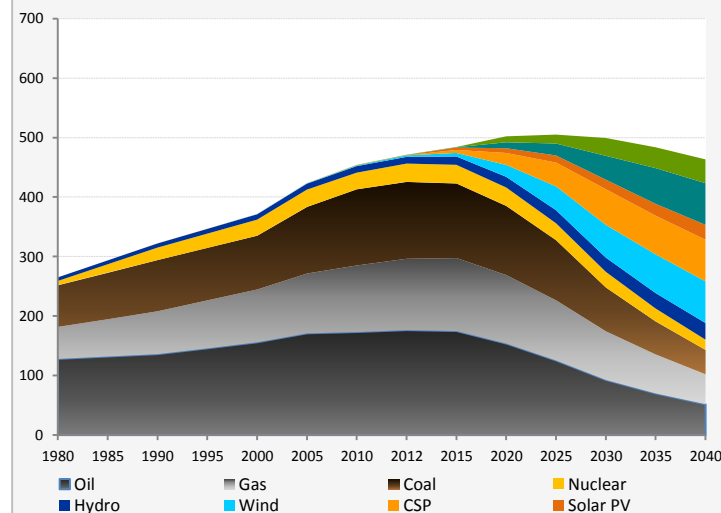
Energy-related CO₂ emissions

Renewable energy technologies do not require fuel, and therefore generate nearly zero emissions (renewable energy CO₂ emissions are limited to emissions from building the infrastructure and negligible maintenance emissions). In line with the changing energy mix from fossil dominated to a balanced fossil-renewable mix, global CO₂ emissions from energy extraction, conversion and usage plateau shortly after 2015 and start to decrease thereafter, accelerating with the speed of the energy infrastructure transformation. However, due to the time delay and inertia of the the climate systems, climate change effects and impacts are expected to increase until the second half of the 21st century before easing off even under the Marshall scenario.

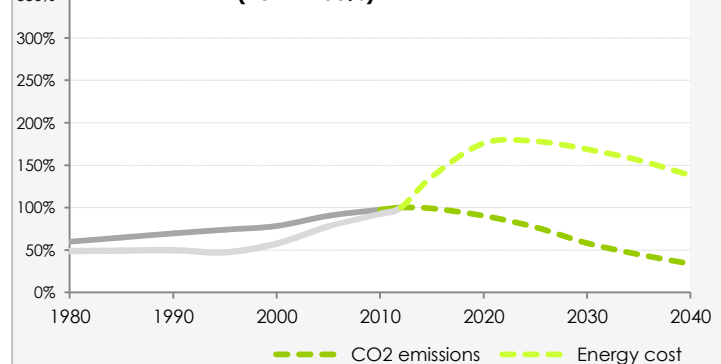
Energy costs

Due to the significant up-front investments required, global end-user energy costs rise marginally higher in the initial phase of the Marshall scenario up to 2017 compared to the BAU scenario (but lower than under the TINA scenario). However, once the economics of scale effect kicks in, drawing further private capital, energy cost peak and start to decrease after 2020. While fossil energy costs increase due to higher exploration cost, the availability of alternative (renewable) energy sources, the margin between fossil energy demand and supply does not become critical, reducing fossil energy spot-prices compared to the BAU and TINA scenarios, positively affecting long-term end-user energy cost. However, energy costs are rising significantly until 2020, a fact that businesses have to be prepared for regardless of the scenario.

Marshall Scenario: energy mix

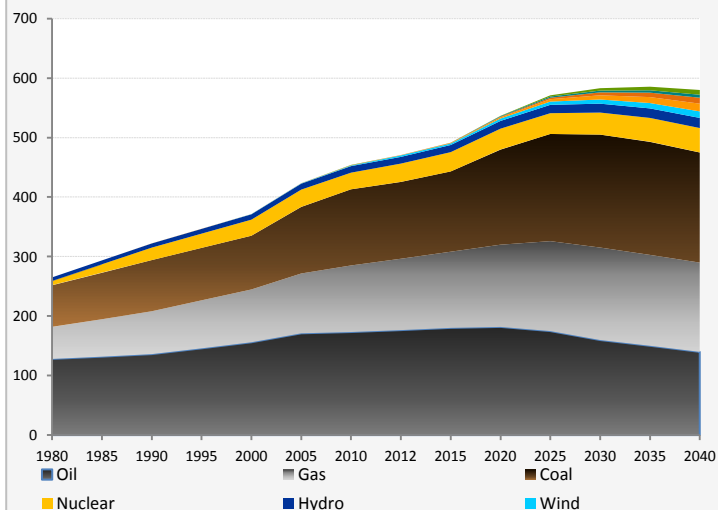


Marshall : energy cost and CO₂ emissions (2012=100%)



TINA – there is no alternative

TINA Scenario: energy mix



TINA : the energy mix

The energy mix under the TINA scenario will remain nearly unchanged until 2025, when supply shortages and prohibitive high cost of fossil energy due to rising exploration cost and market expectations of supply pressure turn renewable energy alternative economically viable. However, the lack of previous investment in R&D and alternative energy infrastructure is delaying a significant contribution of renewable energy to the global energy mix until post 2035.

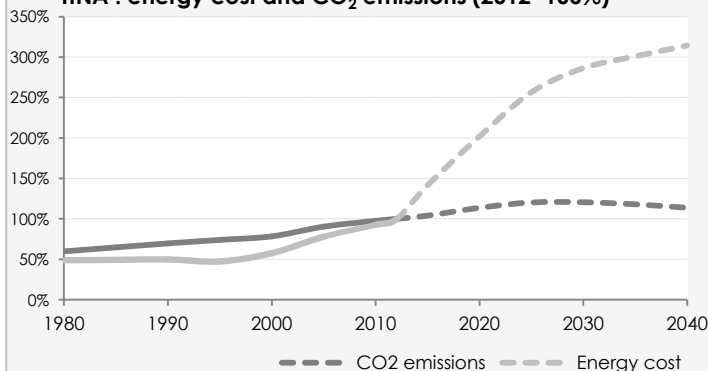
Energy-related CO₂ emissions

Renewable energy technologies do not play a significant role under the TINA scenario. CO₂ emissions are therefore set to increase in line with increasing energy consumption. As oil is becoming more expensive, coal will be more widely used. Given the current state of carbon capture and storage technology (CCS) and a lack of public support, it is not expected that CCS will have a real impact on global CO₂ emissions within the timeframe of the scenarios. Global CO₂ emissions are expected to increase by more than 20% until 2025, and marginally decrease thereafter. The increased CO₂ emissions implies a further acceleration of increasing climate change effects and impacts on society and businesses. At best, climate change impacts will see some easing towards the end of the 21st century under the TINA scenario.

Energy costs

Power plants have an average lifetime of 60 years. Exploration projects are also long-term investments. Energy infrastructure development therefore requires long-term planning. The TINA scenario assumes that free-market radicals are keeping a significant power over key policy decision making. Under this scenario, no national energy policies are implemented. As a consequence, increasing demand in line with economic and population growth coupled with insufficient efficiency measurements lead to rapidly increasing pressure on supply, and the margin between supply and demand of oil will become critical in the near-term future. The critical margin also leads to increased commodity speculation, further adding to sharply increasing end-user energy cost until 2020. The lack of meaningful investment in alternative and renewable infrastructure (relative to global energy consumption) means that the end-user energy price will remain depending on the increasing spot price for oil. Businesses have to be prepared for heavily increasing energy costs that could triple until 2025 compared to 2012 levels.

TINA : energy cost and CO₂ emissions (2012=100%)



Scenarios: conclusions

Scenario likelihoods

Business need to be planning for the future under certain scenarios. Based on current economical and political sentiments, eventuality factors for the different elements of the scenarios (click [here](#) for scenario elements) can be attached, simulating the eventuality for each scenario. Under current circumstances, the business-as-usual (BAU) scenario has the highest likelihood by a large margin, followed by the TINA scenario and Marshall scenario (see chart to the right)

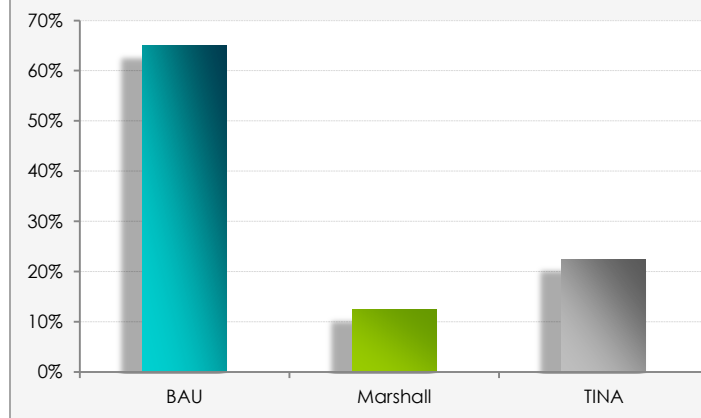
Sentiment changes over time

The circumstances will be changing rapidly under each scenario. The level of impacts are highly likely to lead to future amendment of policies based on developments. Steeply rising energy prices are expected to lead to policy adaption towards the Marshall scenario policies after 2015. With increasing frequency and ferocity of climate change induced weather extremes and natural disasters, coupled with further rising fossil energy spot-prices, the adaption of Marshall-scenario-like policies is expected to rapidly accelerating after 2020 through implementation of climate change and energy policies.

However, economic systems are characterised by inertness. Policy changes do not lead to immediate changes on the ground. Implementation and, more importantly, results only materialise after a certain incubation time. In addition, investments made in the development of energy technologies and generation installations are long-term investments.

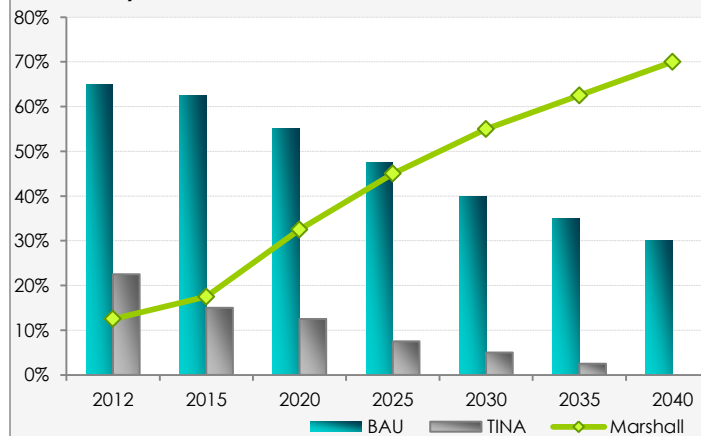
Reversing climate change would take decades even under the Marshall scenario due to the complexity and inertness of the climate system.

Scenario likelihood (2012)



Current likelihood of policy scenarios (2012)

Policy likelihood over time



Changes in the policy likelihood over time



climate change,
energy,
& businesses



4

quantitative impacts
on industry sectors

Forecasting to 2040: measuring the impacts

Impact measuring methodology

The impacts of climate change, GHG & climate change regulation, and rising energy costs on businesses depends on the business field of a specific company. Service provision companies for example are not directly affected by climate change, even if changes should rapidly lead to severe extreme weather events and natural disasters. Other industries are either directly (in their operations, e.g. mining companies) or indirectly (through supply shortages or supply chain disruption, e.g. food & beverage industries) affected by physical impacts of climate change. The same applies for rising energy cost: industrial businesses active in heavy industrial manufacturing, materials (cement) or utilities are strongly affected by rising energy cost, for service providers (e.g. banks) energy cost are marginal, even if they should rise significantly.

The climate change & energy impact analysis therefore has to be conducted on an industry-sector basis in order to evaluate future risk/opportunities for businesses.

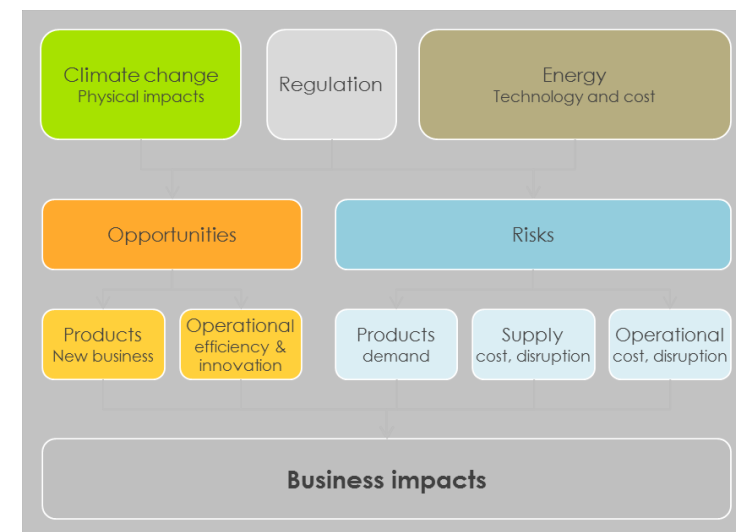
Negative impacts (risk) of climate change, rising energy costs and related regulations have been evaluated against three major criteria under each scenario as described in chapter 3 of this report:

- **Operational impacts:** Direct impacts on operations (operational costs, operational disruptions, potential damage to facilities and infrastructure)
- **Supply chain disruptions:** Supply chain impacts on the business (supply chain disruptions, due to climate change, cost increase due to rising energy costs in the supply chain)
- **Products and services:** Impacts on demand of sector products/services due to climate change/rising energy costs

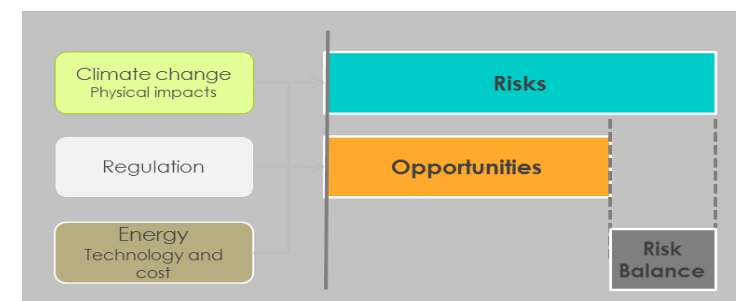
The same analysis has been conducted to **business opportunities**

- **Operational opportunities:** Potential for reducing energy cost through internal process and equipment innovation, new business models, production processes, and climate change damage prevention management
- **Business opportunities:** Market demand for new products, services and business models related to increasing energy cost, climate change damage prevention management, and climate change adaption

The results of this analysis for selected industry sectors is presented on the following pages.

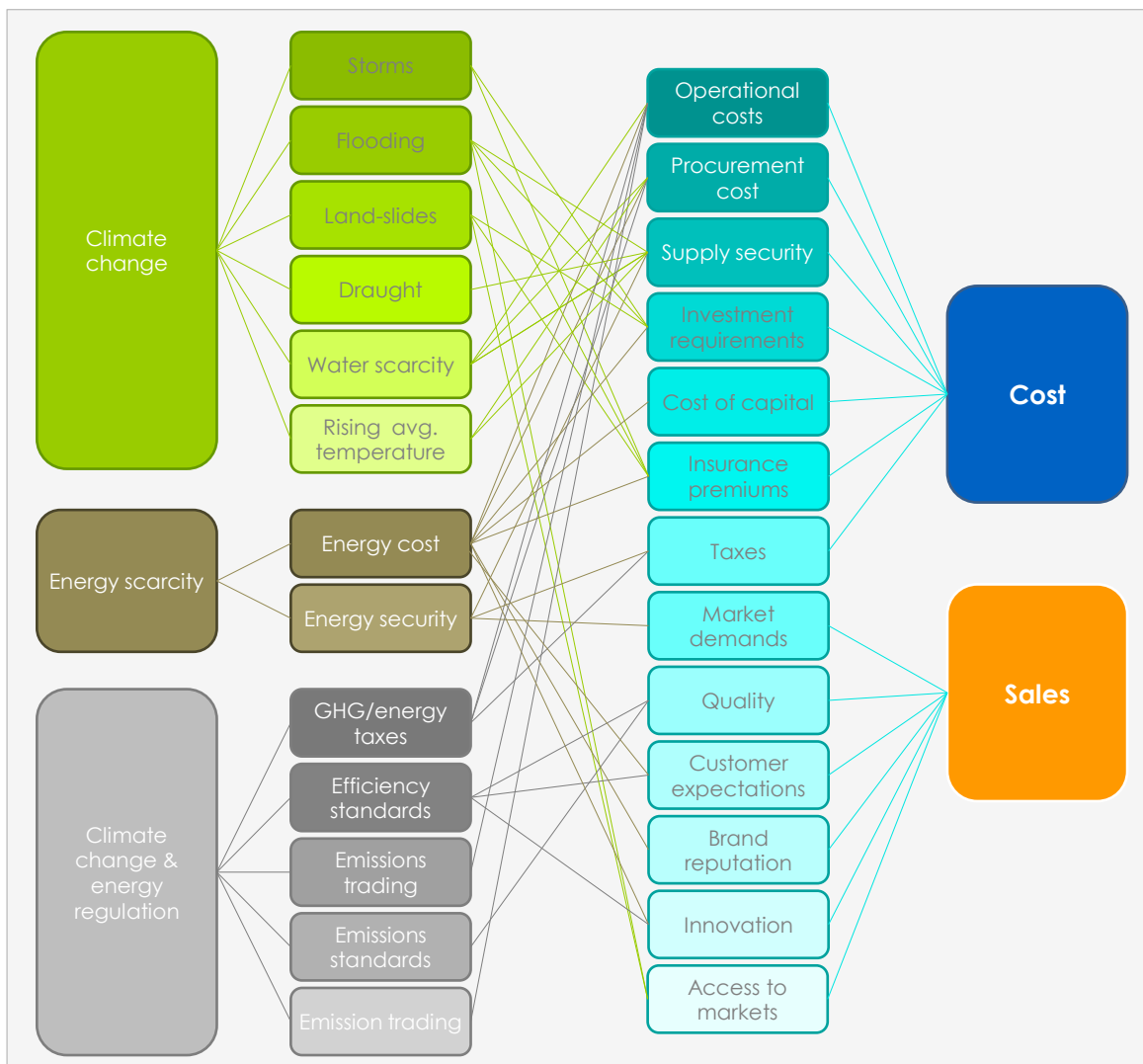


Risks and opportunities to business deriving from climate change impacts, regulations, and rising energy cost



Quantifying risk and opportunities leads to a balance between negative and positive impacts.

Methodology: breakdown of bottom-line impacts



Bottom-line impact breakdown

The impacts of climate change, energy scarcity and subsequent rising energy costs, and associated climate change or energy regulations are influencing different cost and opportunity aspects of a business.

Different sectors have different exposure to energy cost fluctuations and climate change impacts, and need to be calculated for each industry separately.

The quantification of impacts is based on a number of bottom-line factors, mainly

- Direct impacts on operational costs
- Indirect impacts on cost (and stability) of supply
- Impacts on industry markets (changing customer needs, purchase power, and expectations)
- Investment requirements

The calculation of impacts on different industries presented on the following pages have been calculate according to the business impact model on the right of this page.

Climate change & energy: business winners – and losers

Energy, climate change and management capabilities: separating winners & losers

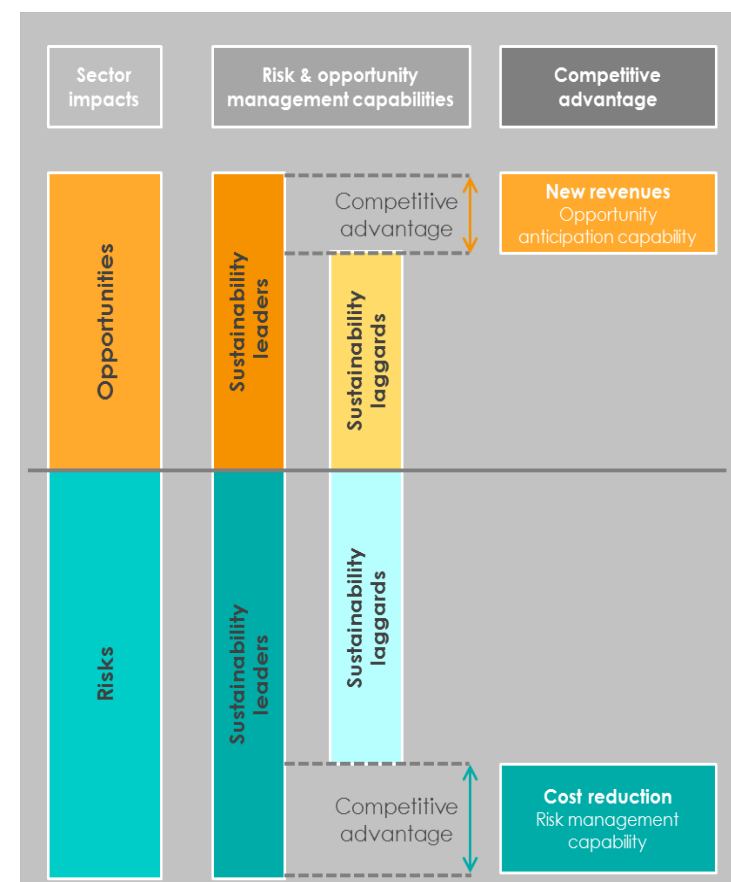
The climate change – energy nexus represents a new set of challenges to businesses. The combined impacts change the business environment in which companies operate, both internally (in terms of operations) and external (in terms of market developments, product/service demands, and customer expectations). All available evidence suggest that we are currently only at the beginning of these developments, which will gradually (but not linearly) have stronger impacts on the way business operate and represent key factors to sustain business success and growth, i.e. are separating future winners from future losers.

Challenges & opportunities

The physical impact of climate change - increasing frequency and ferocity of extreme weather events leading to natural disasters (draughts, flash floods, landslides, etc.) – and rising energy costs pose operational and cost risks to businesses, and could disrupt supply chains and access to markets. At the same time, these challenges represent opportunities for new business and competitive distinction between companies (i.e. rising operational costs also represents an opportunity to increase competitive advantage and margins by developing processes that are more efficient than competitor's processes). The balance between risks and opportunities present the overall exposure of businesses in a specific industry sector or business field. Risks and opportunities – and therefore the risk/opportunity balance – is subject to change over time in the future.

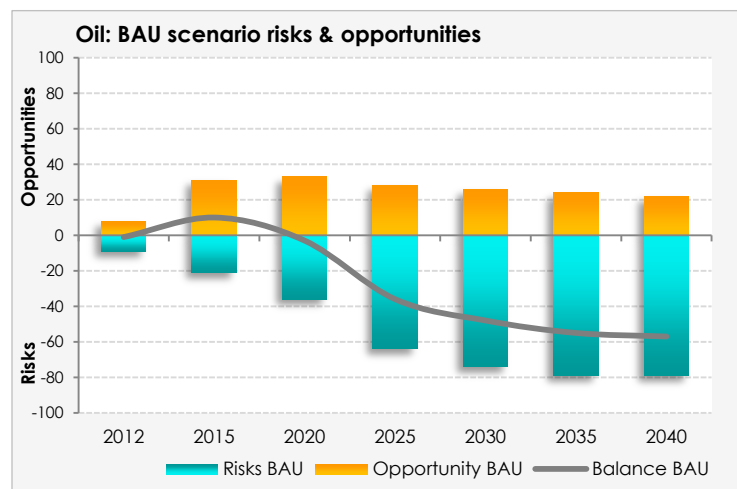
Management requirements

The management of businesses need to formulate timely action plans and roadmaps to prepare the company for the future changes, both internally in terms of process efficiency improvements and external through product/service innovation. Business success and competitiveness are depending on a number of different factors (innovation, quality, price, branding, service quality), i.e. climate change impact management and energy efficiency are not the only factors determining business success. However, intelligent management of the associated risks and pursuing opportunities are key elements of future competitiveness. Intelligent businesses that implement early counter-measurements and action plans with a long-time horizon taking into account future developments are gaining competitive edge through lower operational costs and early entrance in new markets and business fields compared to business without a clear vision of the future and strategic direction.



The future competitiveness of a company depends on its capabilities to recognise and manage risk, while developing opportunities. Assessing the relevant management capabilities allows for identification of future winners & losers, i.e. profitable investment opportunities from an investor perspective.

4.1 Energy - oil



Oil sector

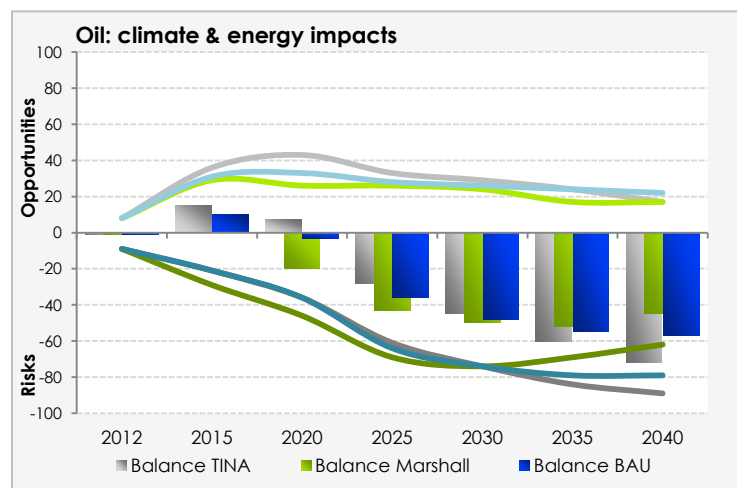
Risk and opportunities in the oil industry depend on business model. Both risk and cost reduction potential are very different in downstream (extraction), mid-stream (refining), and down-stream operations (retail). The analysis presented here is calculated based on an integrated business.

Sort-term outlook to 2020

Due to the lack of meaningful alternatives to oil, demand for oil will keep rising, pushing spot-prices. Real or perceived oil supply fears and the lowering margin between supply and demand is bestowing increasing revenues and profitability profit under the BAU scenario until 2015-2020.

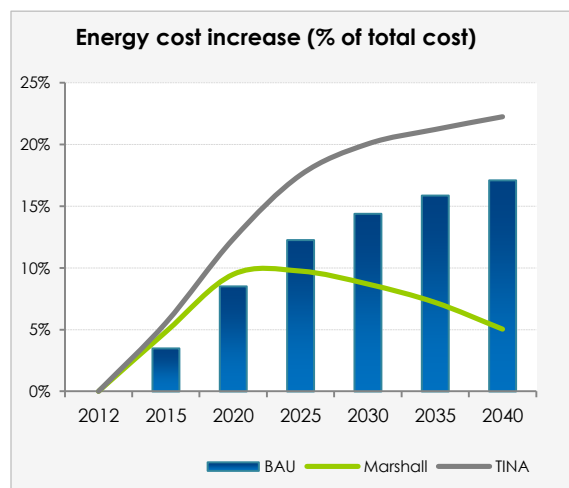
climate change are expected to significantly alter cost and revenue structure in the oil industry after 2025. Furthermore, high fossil energy prices pushes renewable energies to the pint of economic break-even, putting pressure the profit margin after 2025.

The sort term perspective until 2020 looks rosy for the oil industry, and might well yield record profits. However, the managements of companies are well advised to prepare alternative strategies for beyond 2020. In the long terms, oil companies have to consider whether they want to be oil companies only, or energy companies. The latter is most likely a more sensible approach.



Post 2020

Extracting the remaining un-conventional resources when easily available deposits start to diminish is highly capital intensive and costly in operations. Combined with exploration and transport facility damage and transport disruption due climate change induced increase of extreme weather events, risks are increasing steeply after 2020. In addition, competition for resources between companies and nations is increasing, leading to higher license costs and royalty fees. Cost factors and risks are outstripping the margin gained from higher oil-prices after 2020. The combined effects of energy scarcity and



4.1 Energy - gas

Gas industry

Gas is considered the “cleanest” of the fossil energy sources due to lower CO₂ emissions generated in combustion. However, natural gas itself – CH₄ – is a significantly stronger greenhouse gas than CO₂. If the transport losses and leakages (from extraction to combustion) exceed a certain level (2-5%), gas is therefore not “cleaner” than oil, and only marginally cleaner than coal.

Outlook to 2020

Under the BAU scenario, fossil prices are increasing due to demand-supply margin constraints in the short term. As global spot-prices of gas are closely interacting with oil prices, gas companies (especially owner of gas resources) are expected to witness increasing profit margins throughout 2020. Thanks to larger availability of untapped resources and reserves, the time-window for high profit margins due to market demands is longer compared to oil companies.

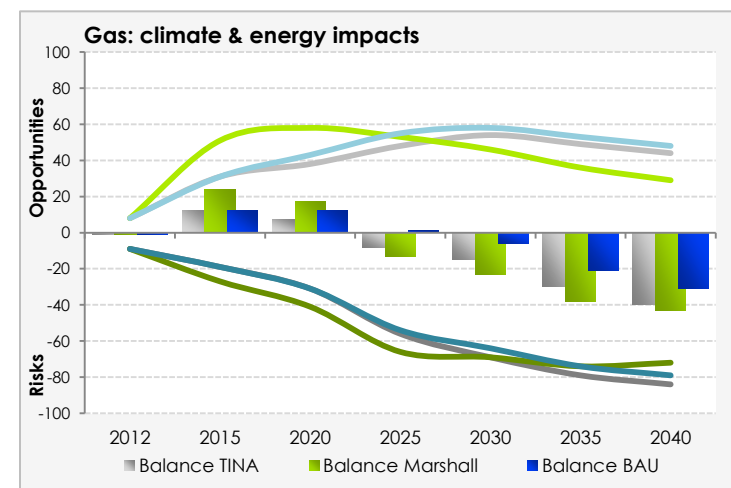
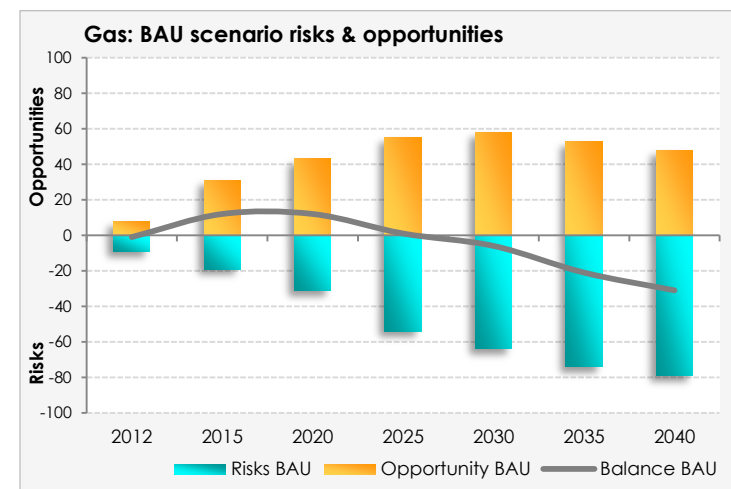
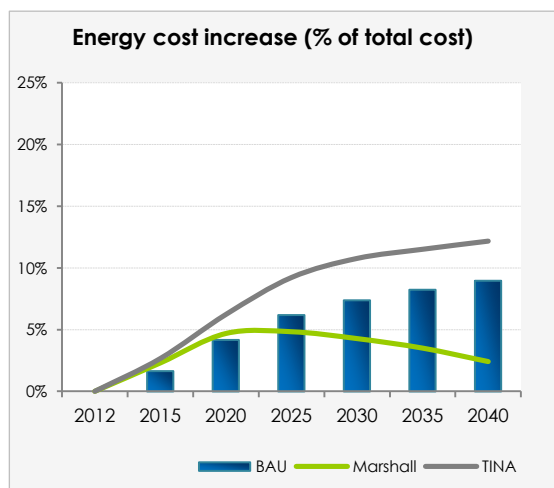
Outlook to 2030

After 2020, climate change effects (in particular extreme weather events), are putting pressure on extraction and transportation costs. In addition, the slow emergence of renewables has a negative impact on the previously high margins. However, opportunities due to high energy prices remain intact until 2030 under the BAU

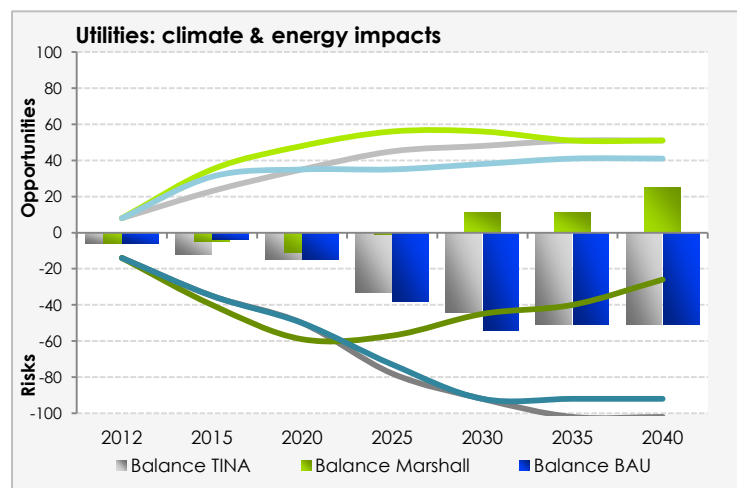
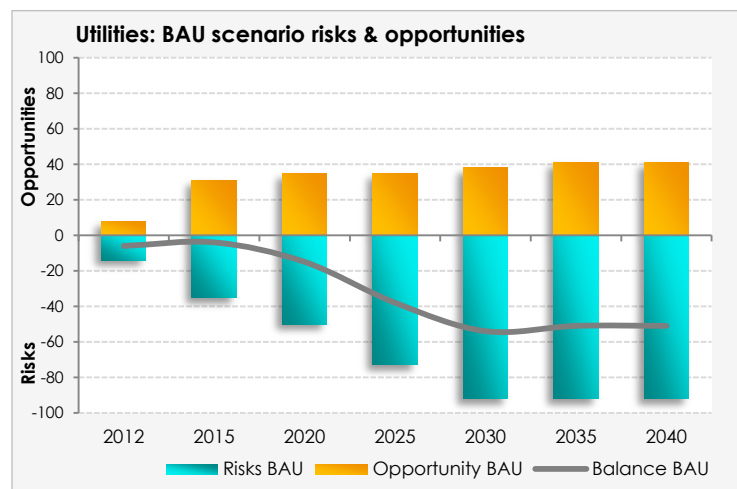
scenario.

Beyond 2030

Known gas reserves and unconventional resources and gas deposits are larger than the remaining oil resources, indicating continued positive outlook for companies that own gas resources. However, climate change effects and competition from increasingly cheaper renewable alternatives are putting pressure on the profit margin post 2030. The high profits before 2030 therefore need to be invested intelligently in order to maintain profitability beyond 2030.



4.1 Energy - utilities



Utilities

Depending on the technology and mix of power plants (thermal fossil based, nuclear, or renewable (hydro)), operational costs of electric utilities are exposed to, and depending on, the fluctuations of fuel market prices (oil, gas, coal). In many countries, electric utilities are under state control or prices are regulated to some extent due to the strategic importance of energy costs. Electricity prices are also subject to scrutiny by the public. In times of rising energy costs, electricity utilities therefore face resistance to passing on the increasing cost to customers, both private and business. In order to escape the dependence, electric utilities can invest in generation technology with lower fuel fluctuation cost (nuclear), or no fuel costs (renewable).

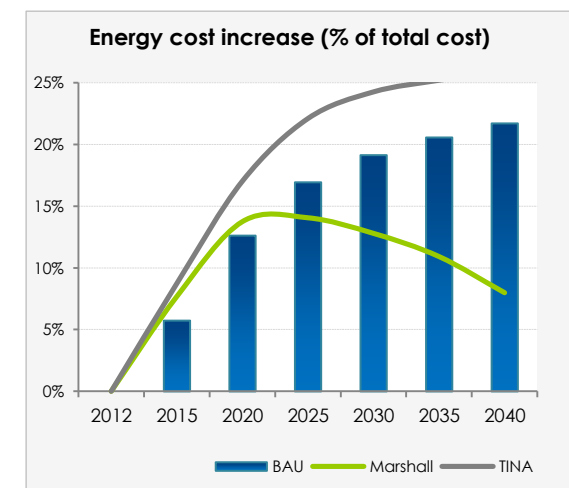
Outlook to 2020

Unless the power generation portfolio of a utility consists mainly of hydro and nuclear power, utility operating cost and profit margins are coming under immense pressure due to rising spot prices on the global fossil energy markets. The lack of timely investment in large-scale renewable infrastructure further adds to this trend. Cost increase will be passed on to customers, hurting economic growth.

Outlook beyond 2020

Considering that power plants are normally

depreciated against a life-span of up to 60 years, management decisions in the utility sector have long-term impacts. Long-term cost structure and profit margins therefore depends on the planning horizons of utility managements, and whether management is taking future fuel cost rise into account. While under current fuel cost calculations a thermal power plant might appear the most profitable investment, rising fuel costs will render renewable power plants more profitable over the life time of the investment. Future profitability of electric utilities therefore depends on the foresight and sustainable management capabilities of the management of the respective business in a much more direct way than most other industries.



4.1 Energy – renewable technology manufacturing

Renewable energy technology

The renewable technology manufacturing industry is expected to flourish as a whole over the coming decades. The industry has not yet reached industrial maturity, with industrial mass-production currently the exception rather than the norm. Wind turbines, which have seen tremendous growth over the past 10 years, are not yet produced in processes that could be called industrial. Stiff global competition will see companies that do not fully industrialise manufacturing processes losing in competitiveness, i.e. there will be winners and losers amongst current players.

Outlook to 2020

Rising energy are increasing economic viability of renewable energy technologies until 2020. However, the lack of infrastructure (grid constraints and the unsolved problematic of storage and provision of peak electricity), the lack of mass production processes for key technologies and the lack of large-scale public investments delay the kick-start of the industry under the BAU scenario.

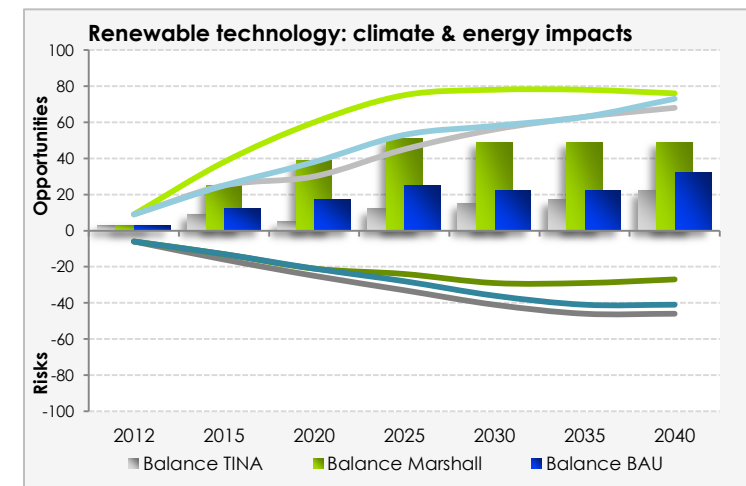
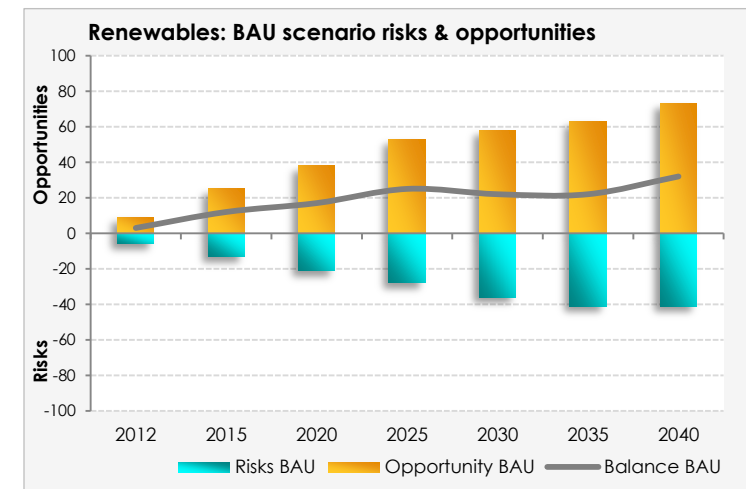
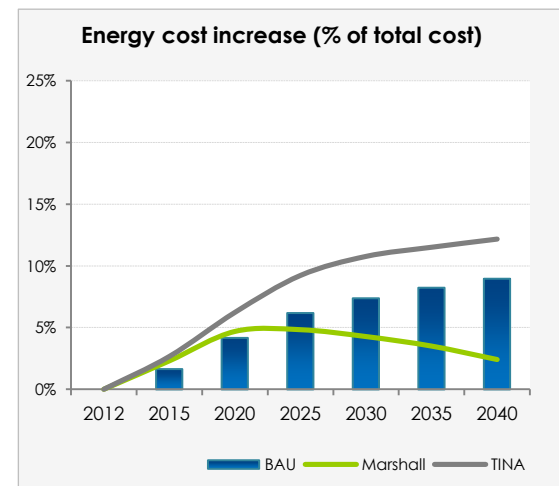
Outlook to 2030

The continuous increase of fossil energy prices and the emergence of some mass-production is kick-starting the renewable energy technology between 2020 and 2030. However, key technologies (solar thermal power generation, wave and tidal

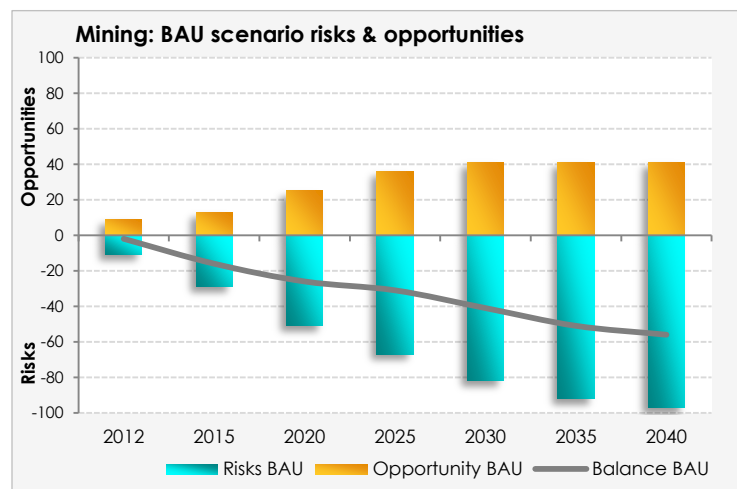
technologies) will only enter mass production towards the end of the decade.

Beyond 2030

Due to the rising global price for fossil energy resources, the renewable energy technology manufacturing industry enjoys a very positive outlook. Manufacturing process efficiency and innovation (mass production) as well as prudent budgeting, planning and time/cost adherence in project development are the two single most competitiveness factors.



4.2 Mining – metals



Mining

Demand for metals (steel and other irons for construction and industrial applications) is going to increase with economic growth. Demand for solid metals is tied to construction, which in turn is closely tied to economic cycles. A serious global recession (or worse) following the financial crises therefore would temporarily lower demand for metals, but will kick back in with recovery. Demand for precious metals, used in electronic parts, is somewhat less sensitive to the economic cycles. Market sentiment on true or perceived scarcity leads to increased speculation driving spot prices and margins.

The trends up to 2020 are continuing into the 2020s and beyond: further rising energy costs, and higher frequency and ferocity of extreme weather events are further increasing overall operational costs.

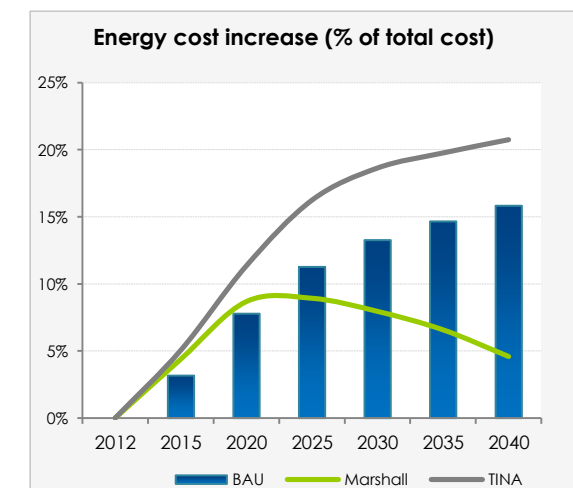
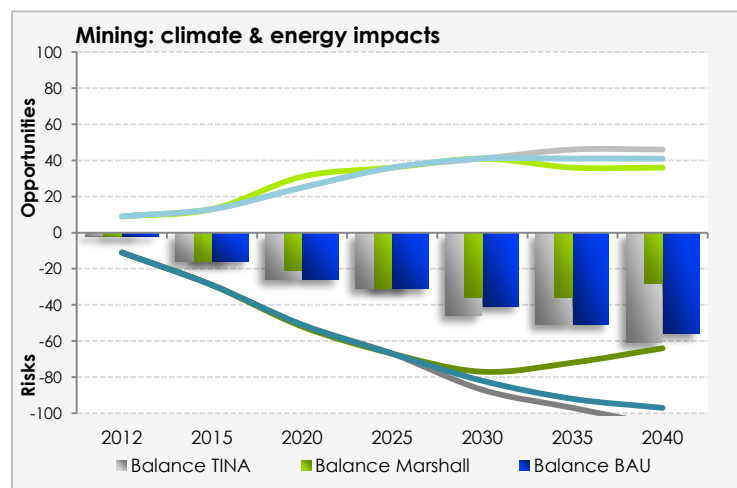
Beyond 2030

There is currently no viable alternative for ferrous and non-ferrous steels and metals, opening the field for innovative companies with alternative approaches. However, increasing metal costs eventually is lowering demand, and initiating the search for alternative material that could materialise post 2030.

Outlook to 2020

Rising energy cost are affecting the cost structure in the mining industry. However, due to the nature of the business, the energy efficiency improvement potential is limited, allowing companies to pass the rising cost to customers. The increasing frequency and intensity of extreme weather events (storms, flash floods) is starting to impact operations and leading to operational disruptions and higher cost for preventive measurements. In addition, increasing water scarcity could affect efficiency of operations or increase cost to transport water from faraway locations.

Outlook to 2030



4.2 Mining – coal

Coal mining

Known coal reserves are abundant and will last for long time (contrarily to oil resources). Accessing future coal reserves will increase operational (extraction) cost, but not in the extend of unconventional oil exploration. Coal is associated with environmental pollution both in extraction (e.g. mountain-top mining whereby whole mountains are flattened), and the high volume of CO₂ emitted in combustion of coal in thermal power generation or iron ore smelting. However, public environmental concerns have not have significant effects on price or usage developments. The business development of coal mining companies therefore mainly depends on the market price of coal. The market price of coal is closely interrelated to oil prices – fears of oil shortages immediately increase the spot price of oil, and therefore coal. While this correlation is expected to lower with steeply rising oil prices, the price of coal – and therefore profit margins of coal companies – will increase in the near future.

Outlook to 2020

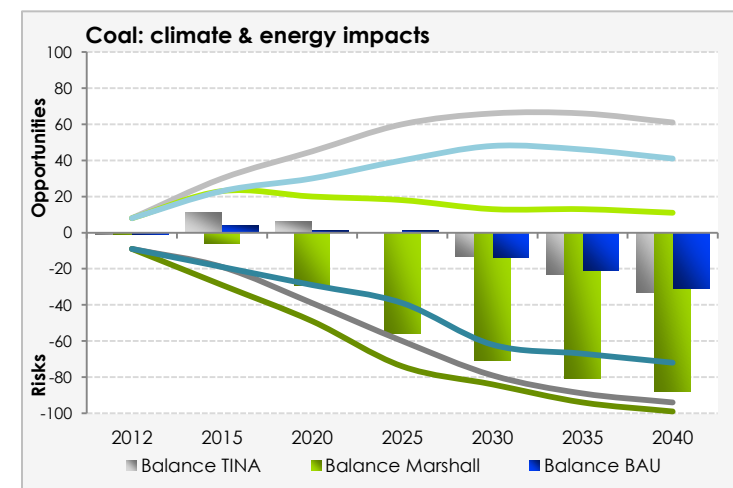
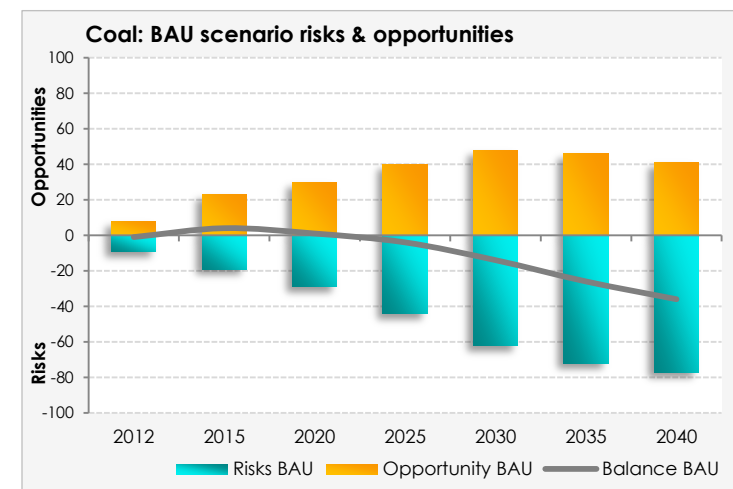
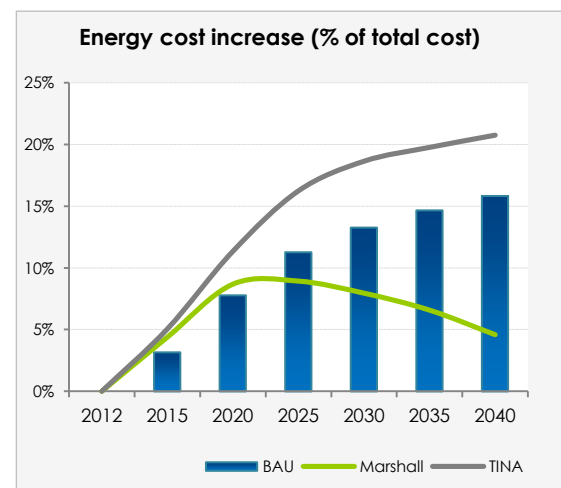
Opportunities due to higher coal prices as a consequence of steeply rising oil prices outweigh business risks until 2020 in the BAU scenario. Physical impacts of climate change (extreme weather events) are starting to impact coal mining operations

Outlook to 2030

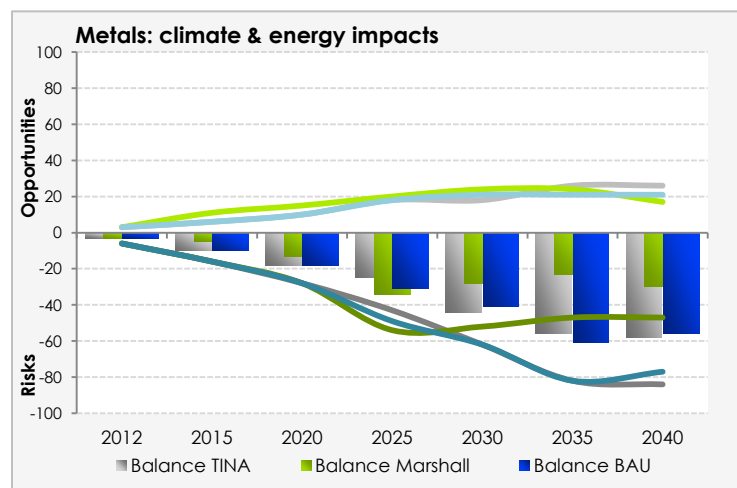
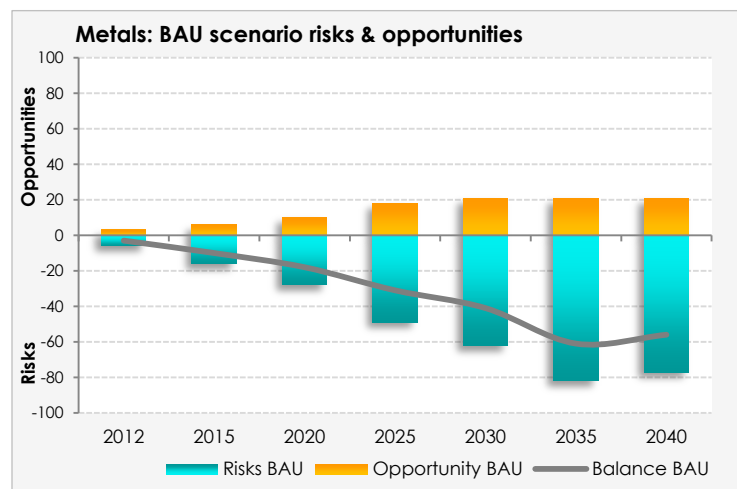
Rising frequency and ferocity of climate change induced extreme weather events and water scarcity are increasing pressure on operational costs and transport costs. However, the price of coal is further increasing due to the lack of meaningful non-fossil energy infrastructure. Under the unlikely Marshall scenario, profit margins would be negatively affected due to the availability of cheap renewable energy.

Beyond 2030

Energy cost are expected to increase throughout the 2030s. However, rising cost due to climate change impacts are outweighing the positive effects of higher prices.



4.3 Materials – metals



Metal industry

Climate change and energy scarcity are effecting the metal industry in two ways: raw material cost and operational costs. Physical impacts of climate change on mining operations and energy scarcity, combined with increasing commodity trading and speculations, are driving the prices of raw materials. As the metal industry itself is highly energy intensive, operational costs, overall cost structure and ultimately profit margins are negatively affected by rising energy costs.

Outlook to 2020

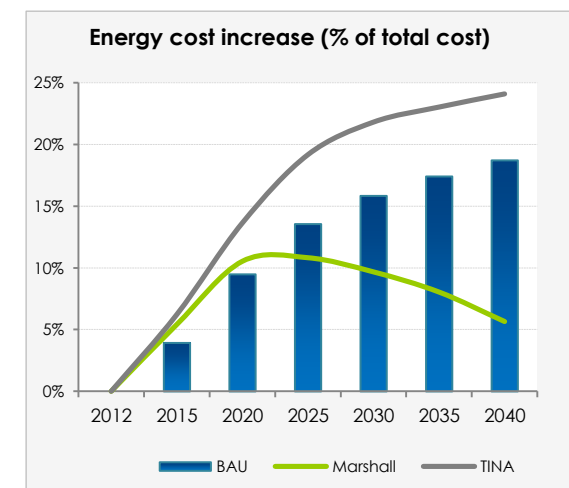
Increasing energy cost, and increasing raw material costs are putting pressure on metal businesses cost structure. Process innovation and increasing efficiency is key to maintain and increase competitiveness in terms of cost. Regional differences in local availability of cheap coal (lower transport cost) could impact the global competitiveness of metal businesses.

Outlook to 2030

Physical impacts of climate change are expected to increase significantly post 2020 in the form of extreme weather events (draught, flash floods, and storms, driving mining costs (i.e. raw material costs)). In addition, energy costs are increasing further under the BAU scenario, further increasing the importance of driving operational energy efficiency.

Beyond 2030

Under a global GHG regime, metal businesses could be forced to adapt strict GHG emissions control. However, such a scenario is highly unlikely and not part of the BAU scenario. Energy efficiency will be therefore be a main driver to maintain competitiveness over the coming decades. Technology developments will also impact the industry. While there is currently no viable alternative to metals for construction purposes and countless industrial applications, new alternative materials with similar characteristics might be developed and mass-produced at some point in the future. Sufficient R&D activities are therefore another key success element in the metal industry.



4.3 Materials – chemicals

Chemical business

Impacts of climate change and energy developments on chemical companies depend on the business portfolio and focus of the company. Petro-chemical companies have a high risk exposure, both in terms of raw material cost and operational costs. Agro-chemical's exposure is somewhat lower, while fine chemicals exposure is even lower. The analysis presented here is based on an integrated chemical business.

Outlook to 2020

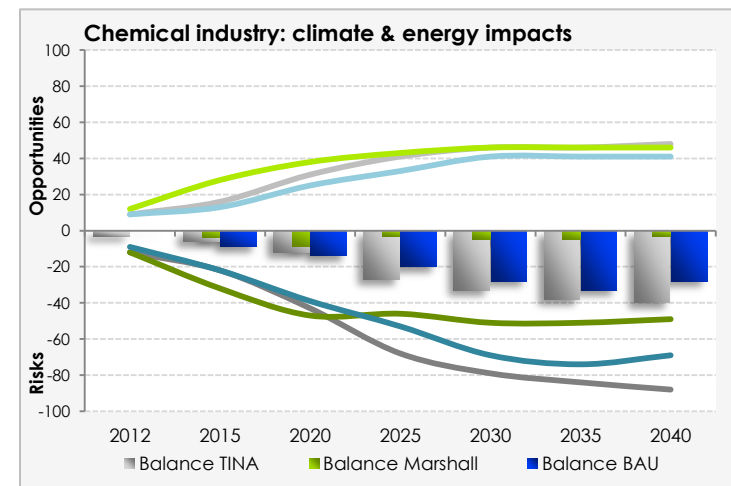
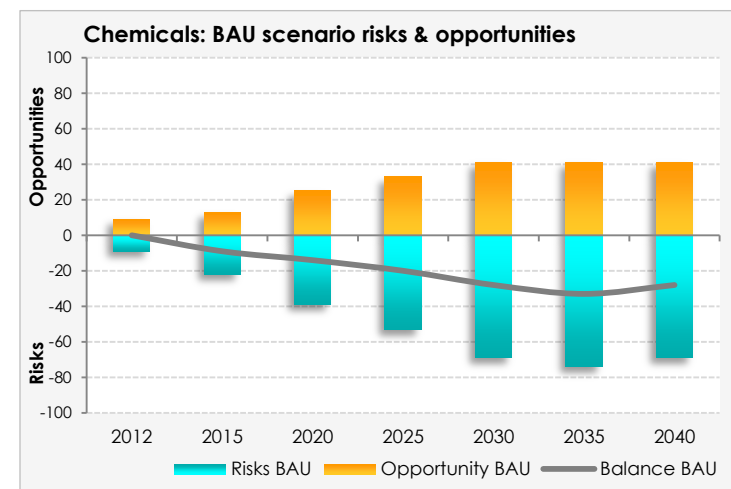
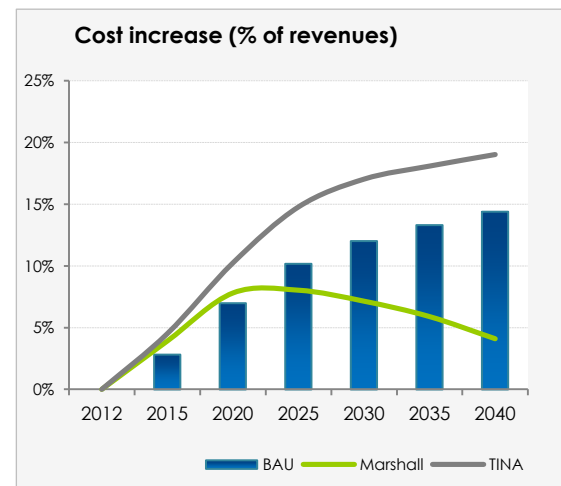
Rising energy fossil energy and raw materials cost are significantly increasing cost of sales until 2020 under the BAU scenario. However, new technologies and efficiency improvements require new innovative materials. While climate change and energy scarcity bring pressure on the cost side, there is significant potential for cost efficiency improvements and the development of new business lines related to smart and intelligent materials, alternative material bases and processes innovation.

Outlook beyond 2020

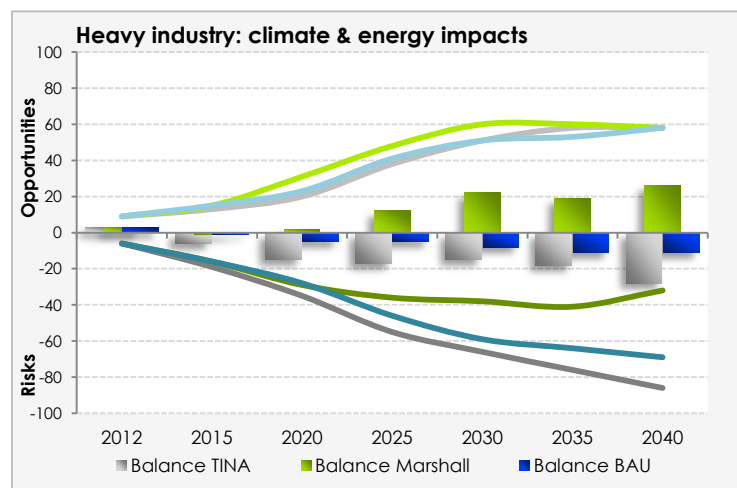
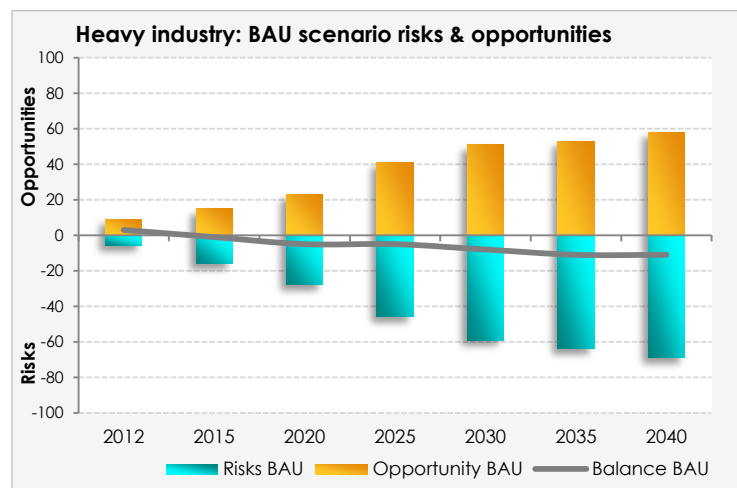
Cost pressure is further increasing beyond 2020 due to rising raw material and energy costs. However, opportunities keep increasing in line with increasing fuel and raw material costs.

Outlook beyond 2030

Business success and profitability in the chemical industry depends on management capability to anticipate future trends through adapting a sustainable (i.e. long-term) business plan. Innovation - both in terms of process efficiency and development of new product lines - remains key for sustained business outlook.



4.4 Industrials – heavy industry



Heavy industry

Physical impacts of climate change on the heavy industry are limited to possible damage to facilities (which can be prevented with corresponding prevention measurements, albeit at a certain investment cost) and possible temporarily interruption to market access and other supply disruption. In light of rising energy cost, customer's will allocate higher importance to the evaluation of maintenance and operating costs of products when making major equipment orders. Product energy efficiency is a therefore a key driver in the heavy industry, coupled with internal efficiency improvements to reduce operational costs.

Outlook to 2020

Rising energy cost are forcing businesses to improve their internal operation eco-efficiency to stay competitive. Direct impacts of climate change are limited to 2020, but could lead to temporarily operational disruptions or disruptions of supply, in particular of basic materials. Product efficiency is fast becoming an additional key factor (besides quality & purchase price) for customer choices and therefore competitiveness after 2015. The totals risks and opportunities are in balance until 2020.

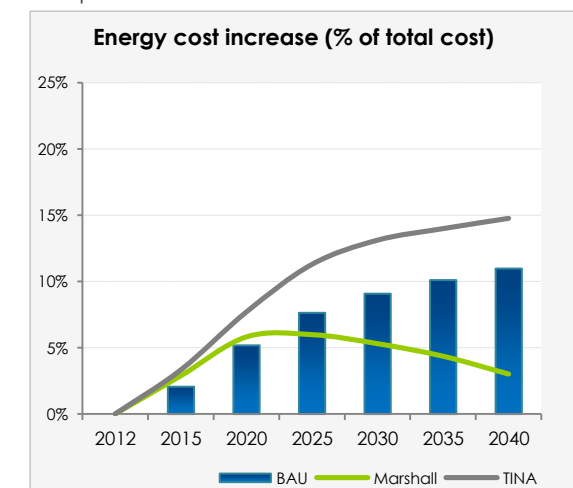
Outlook to 2030

Further rising energy cost continue to increase

the importance for internal efficiency and product efficiency throughout the 2030s and beyond. In addition, climate change impacts are leading to increased raw material sourcing cost and possible supply disruptions, making business planning less predictable. Risk now outweigh opportunities.

Beyond 2030

Further rising risks due to energy cost and increasing instability of supply of raw materials require delicate management capability in order to guarantee continued business success. However, the industry is also witnessing new business opportunities related to energy efficiency and climate change, making R&D capabilities another key competitiveness factor.



4.4 Industrials – vehicles & transportation

Automobiles & vehicle manufacturing

Branding – a combination of history and designed customer perception – are the key success elements for car manufacturing businesses, and energy cost and climate change will not change the main success equation. However, increasing energy costs and the global discussion on CO₂ emissions are putting increasing pressure on car and vehicle manufacturers to increase energy efficiency and reduce GHG emissions of cars. The complexity of, and the need for speed in lean management supply chains as prevalent in the car industry could expose the industry to supply and delivery disruptions due to increasing physical impacts of climate change over time.

Outlook to 2020

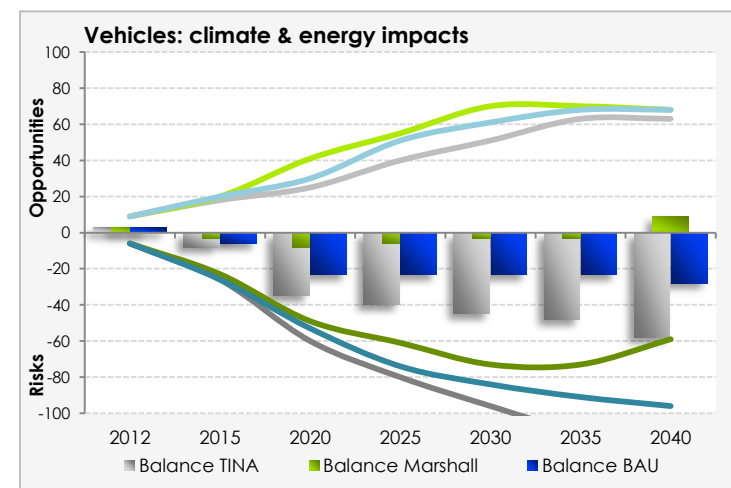
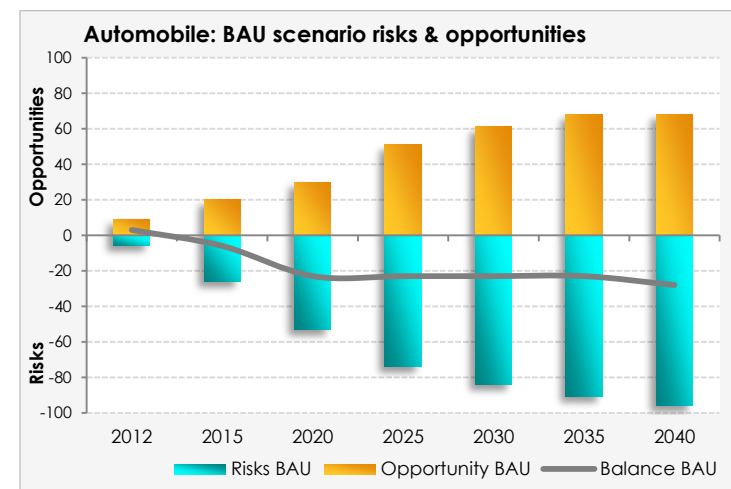
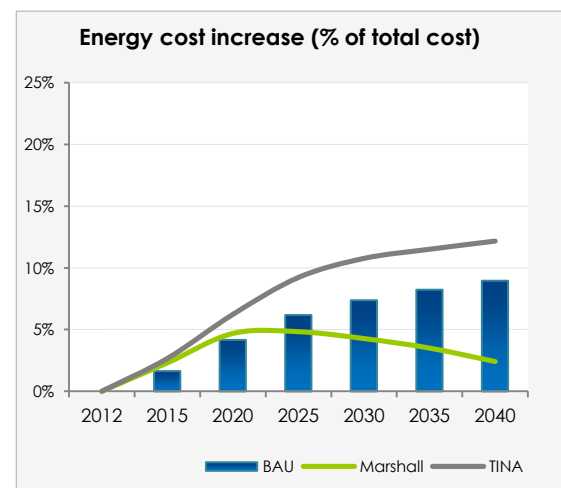
Energy cost are increasing significantly until the end of this decade, forcing business to adapt through development of high-efficient cars and alternative power trains. However, as electricity costs are increasing in line with the oil price, electric cars might not be the only answer. More important than the fuel is the overall efficiency. Manufacturers that are already having more efficient models on the market are in a position of competitive advantage. Internal efficiency is affecting cost structure and margins, but not to the same extent as product efficiency.

Outlook to 2030

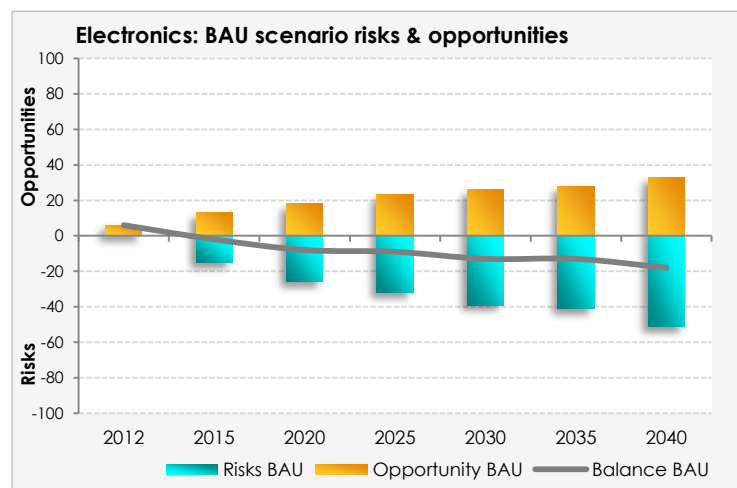
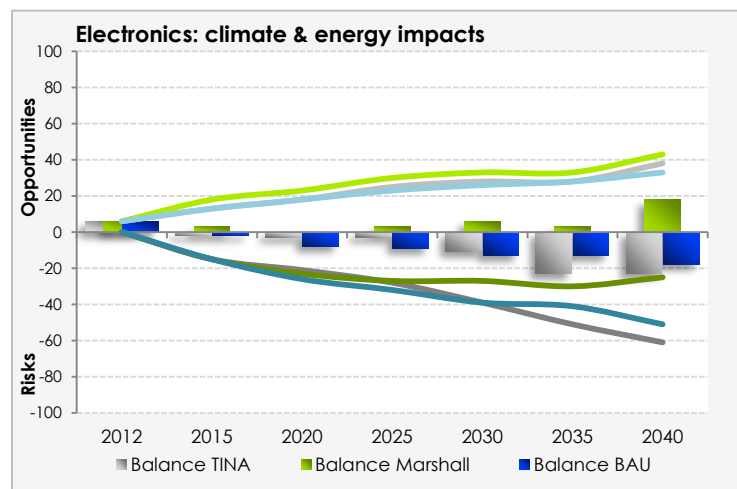
Energy costs are increasing further through the 2030s, requiring fuel and energy efficient cars. In addition, physical impacts of climate change and extreme weather events are leading to increased supply and delivery disruptions, leading to increased operational costs and instability in the business environment.

Beyond 2030

R&D advantage is key to continued business success. As new models of both private and public transport and mobility means are emerging, car vehicle and other transport gear manufacturers will have to decide whether they identify themselves as car companies or mobility provider businesses.



4.5 Electronics



Electronics industry

Businesses producing electronic devices and parts are subject to increasing energy costs, leading to rising operational costs. Energy efficiency is therefore a key element of sustaining competitiveness. The industry's direct operations are not significantly affected by physical impacts of climate change. However, the industry relies on lean supply of parts. Extreme weather events could lead to supply disruptions due to transport constraints or lack of supply of raw materials in the supply chain, negatively affecting capacity utilisation.

In addition, a wide range of metals is used in most electronic devices. Climate change impacts in the metal mining sector could lead to shortages of important materials or supply disruption. R&D activities to develop alternative materials to substitute key materials is therefore another critical issue.

On the opportunity side, smart devices, systems and services to manage and counter climate change effects and rising energy cost (e.g. metering, monitoring and management systems as well as systems related to water treatment, irrigation and cleaning) represent new business fields and opportunities.

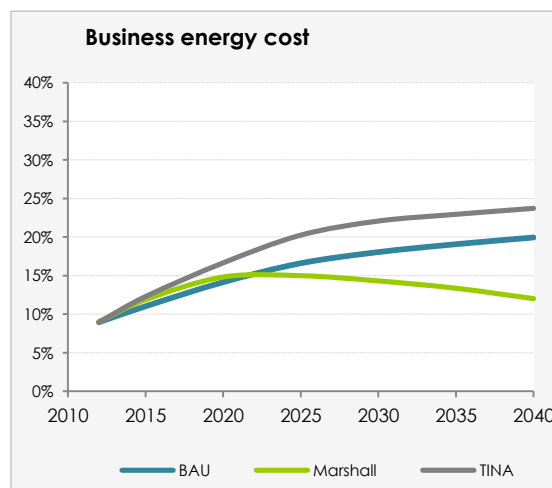
Outlook to 2020

Business risk and opportunities are in balance until 2020. Increasing energy costs are leading to higher cost, which need to be

compensated with higher internal efficiency. High energy efficiency and innovation capability to capitalise on the new business opportunities are key factors for maintaining a businesses' competitiveness.

Outlook to 2030 and beyond

The balance between risks and opportunities is tipping to the negative after 2020 due to further rising energy cost and unpredictability in the supply chain of parts and key raw materials (precious metals). Improving energy efficiency internally and of products as well as innovation capabilities – both in terms of technology R&D and the development of new business or service models will gain higher importance as elements of competitiveness.



4.6 Consumers – food & beverage

Food & beverage industries

Food and beverage businesses depend heavily on steady, predictable supply of high quality raw materials, i.e. agricultural products. The supply of raw materials in turn depends on the sufficient availability of clean water and seasonal climate. Food & beverage are therefore highly exposed to changes in climate patterns. Increasing frequency of extreme weather events – heat waves, draughts, storms, flash floods – can seriously undermine volume and quality of the harvest. In addition, the predicted warming is changing flora patterns, and the agricultural industry needs to adapt to changing external circumstances. The potential food scarcity leads to high fluctuations and increased procurement costs in the food and beverage industry that cannot be foreseen, increasing cost and undermining long-term planning. In addition, rising fossil energy cost increase prices for fertilisers and industrial agricultural production.

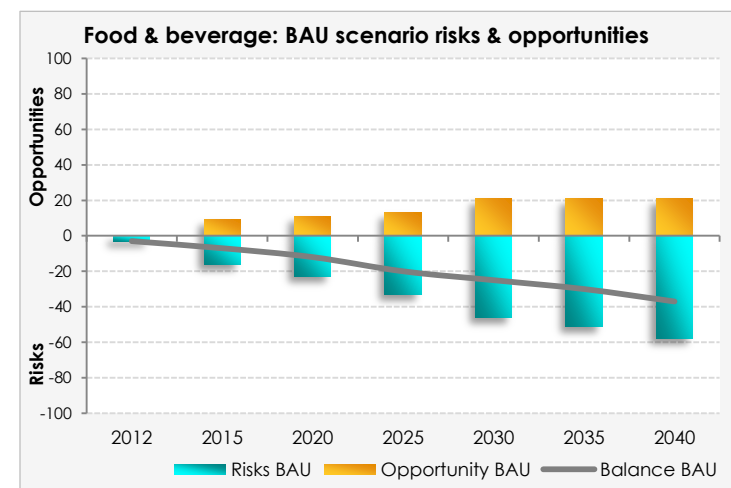
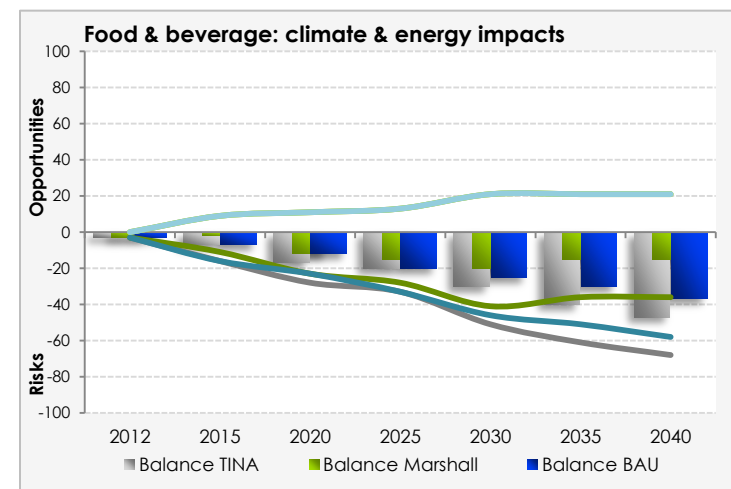
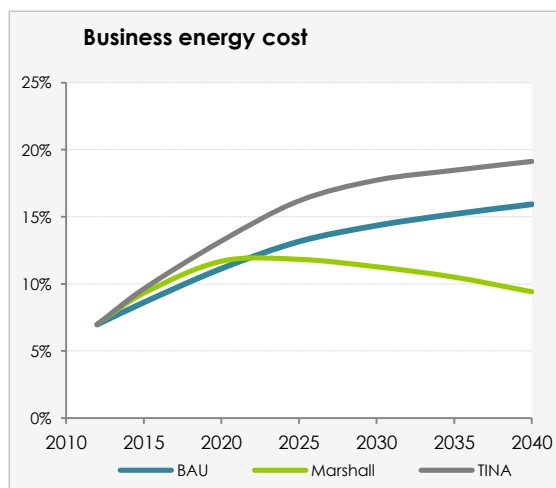
Outlook to 2020

Increasing energy prices lead to higher cost in industrial agriculture (fertilisers, fuel), leading to higher procurement costs. Increasing frequency and ferocity of extreme weather events and natural disasters lead to high fluctuations in raw material prices and increasing overall cost. While there are business opportunities related to healthy and organic foods, organic agriculture is exposed

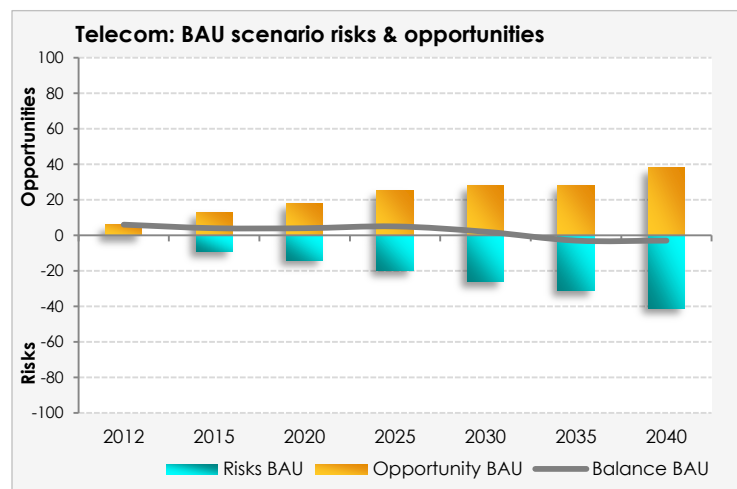
to the same climate impacts as industrial agriculture, i.e. does not represent a full alternative for the food industry.

Outlook to 2030 and beyond

The physical impacts of climate change are getting strong after 2020, further increasing unpredictability and cost in the food and beverage supply chain, pressuring cost structure and margins. However, all producers are affected to the same level. Climate change will therefore only marginally affect competitiveness between different food/beverage businesses. Operation efficiency to reduce internal operations costs represents a competitiveness factor. Internal energy affecting the supply chain of



4.7 Services – ITC (communication)



Telecoms

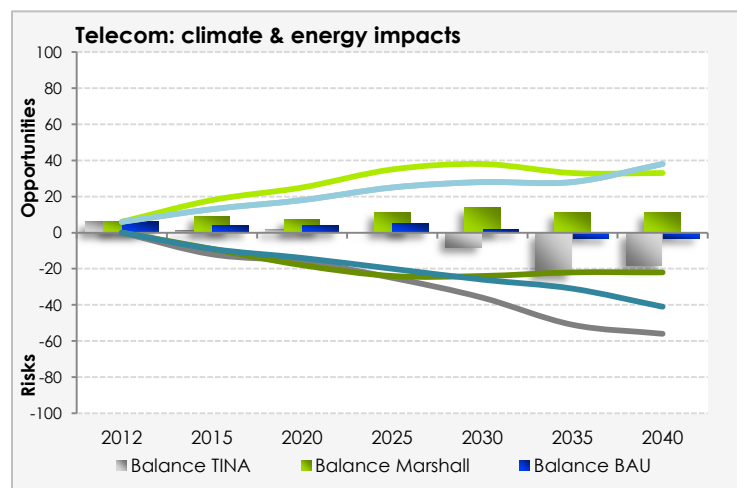
The telecom industry is characterised by rapid technological development. As alternative means of accessing broadband connections are available, the traditional business model and profit margins through establishing connections is under threat. Extreme weather events will increasingly affect the network infrastructure, increasing investment cost for stronger facilities and maintenance costs. At the same time, technology advancements and a set of new challenges open significant new business development alternatives through application of smart technology, e.g. in remote monitoring and management of facilities, installations, and infrastructure.

Outlook to 2030

Rising energy cost and increased frequency of extreme weather events potentially leading to network infrastructure damage is causing pressure on the cost side. However, business opportunities related to both climate change and energy efficiency are rising equally throughout the 2020s.

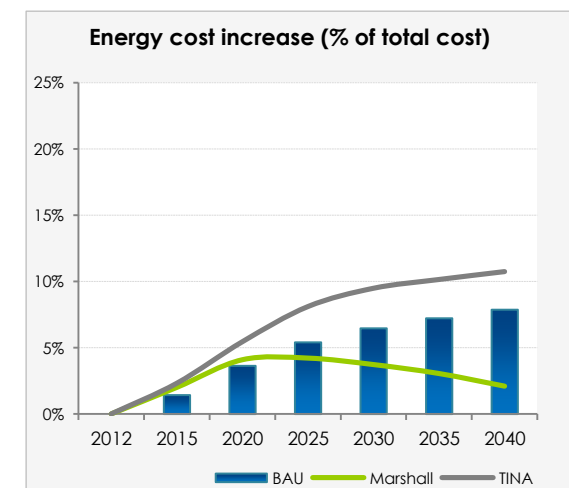
Beyond 2030

Business opportunities are growing less fast after 2030, turning the balance of risk and opportunities into the negative sometime in the middle 2030s due to higher cost to manage the physical impacts of climate change, and continuously rising energy cost in the most likely BAU scenario.



Outlook to 2020

Depending on management foresight and capabilities, telecom businesses enjoy the perspective of profiting from the challenges imposed by climate change and rising energy costs below the balance sheet line. While operational costs are increasing due to higher energy costs, the need for increasing energy efficiency and early warning systems opens significant new business opportunities for telecommunication companies related to smart remote technology. Extreme weather events are likely to lead to increase network maintenance cost (replacement of damaged network installation & equipment), but will not seriously affect the profit structure.



4.7 Services - tourism

Tourism

Impacts in the tourists industry depends on the nature of the business: local tourism vs. long-haul tourism on one hand, and geographical exposure to climate change impacts on the other hand.

Energy cost increase have limited direct operational impact on the operations other than transport-related businesses (e.g. airlines, tour operators)

Increasing cost of fossil fuel and kerosene are expected to be reflected in significantly higher cost for long-haul flights, negatively affecting tourism in exotic destinations far from countries with a large upper and middle class. Tourism in developing economies therefore to some extent depends on advancements in jet engineering. However, significant efficiency improvement in jet design are not expected in the medium term.

Climate change impacts on tourism are local, and depend on the local exposure to climate change risks: draughts, land slides and lack of snow in the short-term affect mountainous destinations, while possibly rising sea levels affect beach destinations in the long-term.

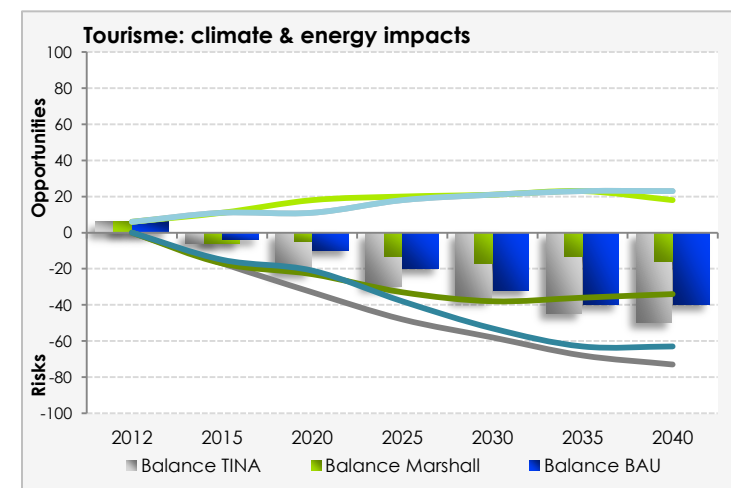
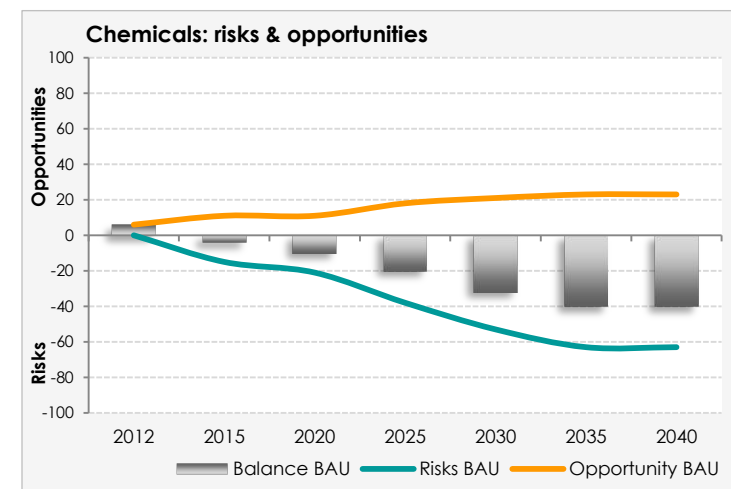
However, changing climate patterns and the changing climate also offers new opportunities for innovative tourism offerings and might lead to a shift from long-haul to local tourism, to some extent compensating for lost business.

Outlook to 2020

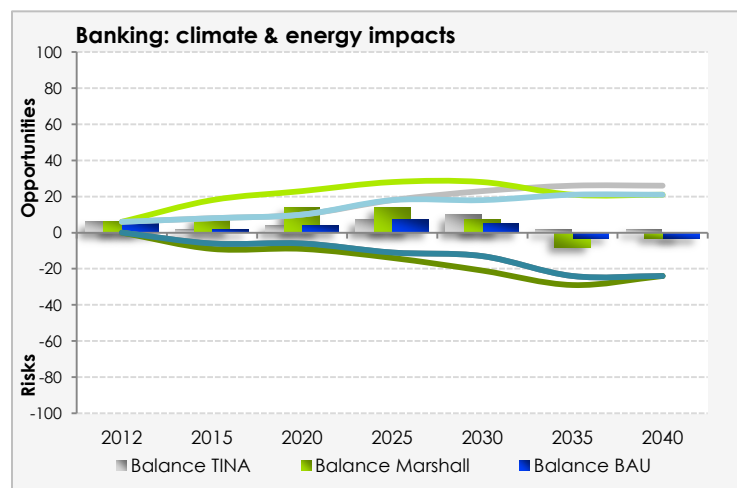
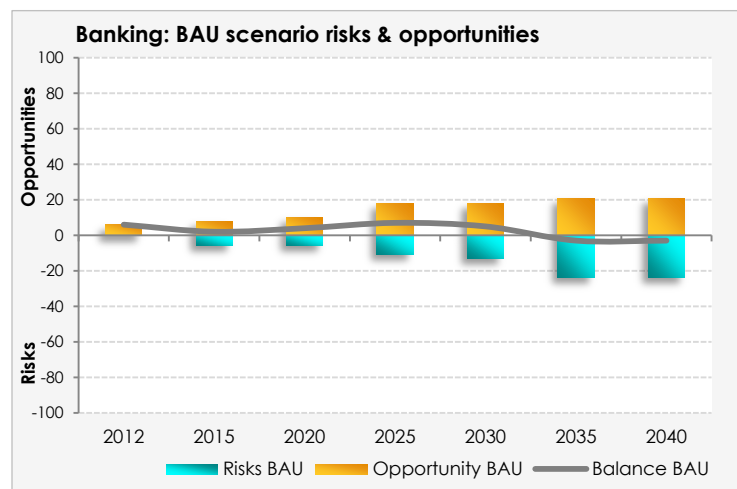
Climate change and energy cost increase impacts on the operations of the tourism industry are limited until 2020. However, locations heavily depending on stable climate (e.g. winter-sport) and locations exposed to seasonal impacts of extreme weather events are expected to be adversely affected. Rising energy cost are expected to negatively affect long-haul tourism to far-away exotic destination due to significant increase in air-travel cost towards the end of the decade, possible leading to a shift towards more local tourism.

Outlook to 2030 and beyond

Climate change impacts are expected to seriously affect certain tourist destinations after 2020 (depending on local exposure to climate change and extreme weather events), with impact increasing thereafter. The impacts on the tourism industry are therefore highly local. Rising sea-levels are not expected to really affect tourism before 2030. At the same time, the changing environment opens new business opportunities for local tourism services and innovative new business models.



4.8 Financials - Banking



Financial industry

The financial industry's energy cost are marginal, and not expected to increase to a level that would make tangible bottom-line impacts. The same applies for exposure to operational risks to climate change effects. However, financing of projects and credit business have to be reviewed from a point of view of the new challenges, both in terms of energy cost risks (energy efficiency) and exposure to climate change, extreme weather events, and climate change induced natural disasters. Banks that fail to take into account the new set of credit and financing risks expose themselves to potential losses though default of investments that fail to adapt to the changing environment. At the same time, viable new financing opportunities are arising for both prevention of climate change impacts and energy infrastructure development.

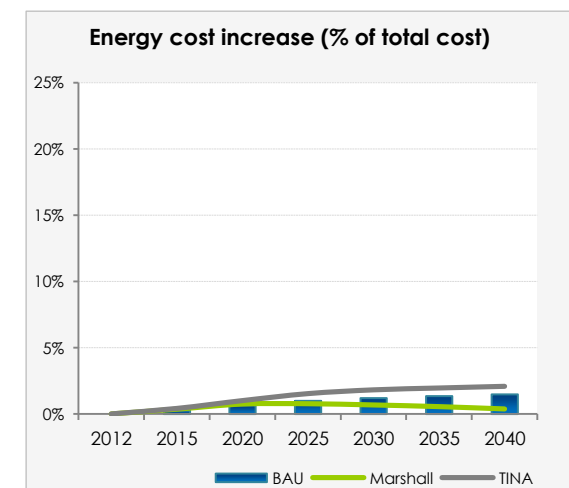
Outlook to 2020

Rising energy prices do not affect the bottom line in the banking industry. However, increasing frequency and ferocity could influence the success and return of financing and credit operations in the absence of comprehensive financing and credit risk modelling taking into account the new set of risks related to energy cost and climate change impacts. At the same time, new financing markets in the form of renewable technology financing and project

development are emerging.

Outlook to 2030

The trends set to 2020 are continuing into the 2020s and beyond. By the middle of the decade, financing opportunities in the renewable energy infrastructure and technology markets opens new business fields and represents opportunities in light of high fossil energy costs.



4.8 Financials - Insurance

Insurance business

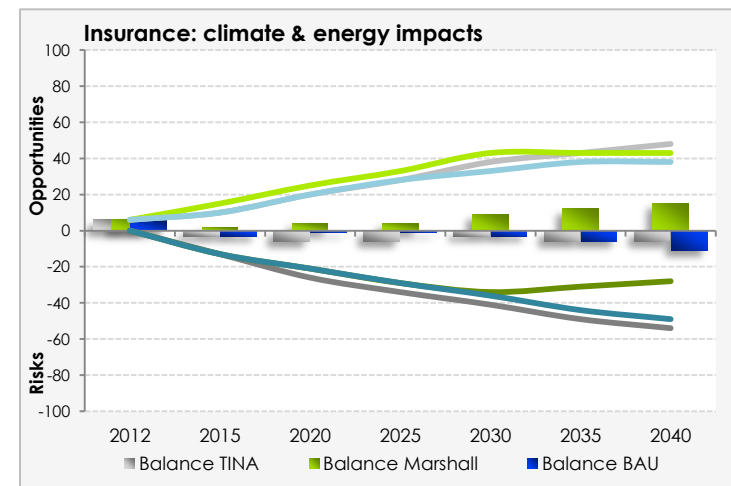
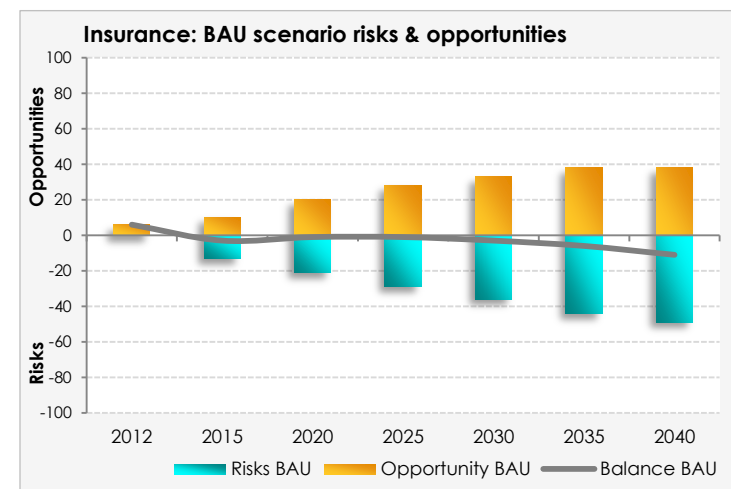
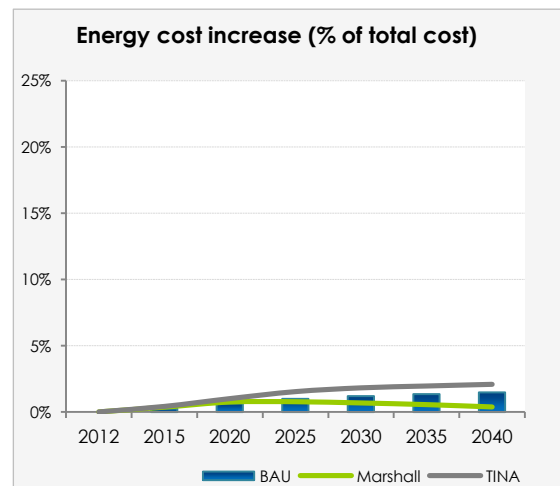
Insurance companies direct exposure to rising energy cost, physical impacts of climate change and GHG regulations is limited. However, rising frequency and ferocity of extreme weather events leading to natural disasters associated with climate change increase unpredictability. Predictability is a key element of insurance risk management to calculate insurance and underwriting policies. Insurance companies therefore need to develop new and complex risk analysis models in order to evaluate financial impacts and insurance policies in such an environment to prevent losses due to extreme weather and disaster events. At the same time, customers might choose competing companies if insurance premiums are perceived as too high.

Outlook to 2020

Statistical evidence of the pattern, frequency and impact of extreme weather events suggest that climate change is already upon us at this point in time. Every indication available further suggest that the frequency and ferocity is going to increase in the decade to 2020, which could lead to massive losses if underwriting policies do not sufficiently pay reference to the new risks. Insurance businesses that fail to develop adapted risk evaluation and insurance calculation schemes are exposing themselves to significant future risks.

Outlook to 2030 & beyond

Frequency and impacts of extreme weather events and natural disasters are increasing further in the 2020s, increasing risks of financial losses due to single extreme or a multitude of smaller events. At the same time, business and private customers will want to protect their investments against the new risk scenarios posed by the physical impacts of climate change, opening a large field of new business opportunities in the insurance industry. Innovative new insurance models based on thorough risk evaluation models are key to maintain profitability and gain new business.





climate change,
energy,
& businesses



5

references
& further reading

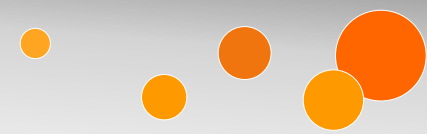


references & further reading

Issuing organisation	Contents	Link
BP	Energy statistics	Website
BP	Energy outlook to 2030	Website
Dii (Desertec industrial initiative)	Desert Power 2050: African concentrated solar thermal power for Europe	Study
European Renewable Energy Council (EREC)	Europe 2050: 100% renewable	Study
Exxon Mobil	Energy data	Website
Exxon Mobil	Energy outlook to 2040	Website
Greenpeace, EREC	Energy(r)evolution	Website
International Energy Agency (IEA)	World Energy Outlook	Website (subscription required)
International Energy Agency (IEA)	National energy statistics for IEA member countries	Website
International Energy Agency (IEA)	Oil market reports	Website
International Energy Agency (IEA)	Natural gas reports	Website
International Energy Agency (IEA)	Energy technology perspectives	Website
IMF	Fuel and non-fuel commodity price statistics	Website

references & further reading (continued)

Issuing organisation	Contents	Link
IPCC	Climate change mitigation through renewable energy	Study
IPCC	Managing risks of extreme weather events and disasters	Study
Munich Re	Natural catastrophe statistics	Website
NREL	USA 2050: 80% renewable	Study
Shell	Future scenarios	Website
Shell	Energy scenarios to 2050	Website
The Shift Project	Global energy and climate data portal	Website
US Energy Information Administration (US EIA)	Energy statistics and predictions	Website
WBCSD	Vision 2050	Website
WBCSD	Energy & Climate Change	Website
Wikipedia	Peak oil: Independent peak oil claim comparison	Website
Wikipedia	Peak coal: Independent peak coal claim comparison	Website
Wikipedia	Peak uranium: Independent peak uranium claim comparison	Website
World Energy Council	World Energy Insights	Website



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