Pillars of the Green Transition

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Critical junctures marking the end of a global era do not happen often. Today, there is substantial evidence to affirm we are approaching one. Governments and companies are facing the consequences of the U.S.-China trade wars initiated in 2018, coupled with the blows of Covid-19. In addition, an inflation- ridden outlook, supply chain disruptions, and the race to combat climate change has led them to juggle survival needs with costs and sustainable choices. As war knocks on Europe's door with Russia's invasion of Ukraine, consequences of a bleak, energy-scarce winter echo in the media and loom ominously over the West. An over-reliance on China's market monopoly in the production of raw materials has left Western economies vulnerable, and one can sense that an inauspicious air is taking over.

However, necessity is the mother of invention, and no crisis comes without an opportunity. Our realization of a problematic dependence on Russia's oil and gas or Asia's materials comes with a silver lining; the possibility of transitioning into a cleaner and more secure economy. In this report, leaders from North America, Europe and Singapore discuss how they are spearheading the green transition through technology, innovation and the will to be a part of the circular economy.

JENNIFER GRANHOLM
UNITED STATES SECRETARY OF ENERGY

How is the Inflation Reduction Act (IRA) incentivizing decarbonization?

President Biden's agenda (including the IRA and Bipartisan Infrastructure Law) is the most historic legislation any country has taken on climate and will collectively do most of the work necessary to not just meet the President's aggressive climate goals, but also build a whole new clean energy economy. These laws will provide over half a trillion dollars in new clean energy investments, and will also require significant investment from the private sector. That level of investment will propel clean energy deployment and innovation like never before. It will significantly bring down costs for zero carbon technologies, which in turn will benefit not just the U.S., but the entire world. With massive incentives to invest in U.S. manufacturing, we are already seeing dozens of new onshoring investments from the private sector. Our goal is to have 100% clean power on our electric grid by 2035.

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FRANS TIMMERMANS
VICE-PRESIDENT OF THE EUROPEAN COMMISSION

Russia's war on Ukraine has shaken up the energy markets across Europe. How has this impacted the continent's green transition plans?

For the short-term, we are focusing on alternative supplies of gas as well as on energy savings. In parallel, we are ramping up the rollout of renewables. Now, just seven months later, only 9% of our gas comes from Russia, compared to 40% previously. Putin's manipulation of energy markets has caused energy prices in the EU to soar, making life for millions of families and businesses across the continent increasingly difficult. But this has not affected our long-term climate targets. Europe's greenhouse gas (GHG) reduction targets for 2030 and 2050 are fixed in law, and we are aiming to finalize negotiations on their implementation by the end of the year. It is true that in the immediate future, we are seeing more coal use than initially projected, but European citizens and governments know that the era of cheap fossil fuels is over, and that renewables are the only lasting solution to make us immune to Russia's energy blackmail. So when it comes to our green transition, the European Union is not only staying the course, we are accelerating.

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Transitioning effectively will require the improvement of processes not yet refined, and a reliance on industries that might still carry negative perceptions. Mining, for example, holds the key to supplying all the necessary materials for copper cabling, solar panels, wind turbines and electric batteries. While sustainable practices within the sector are necessary, it also requires support and investment to continue developing technologies and innovation to scale up and meet exponential demand.

The International Energy Agency noted that oil and gas energy sources will still play a role in 2050, particularly for hard-to-decarbonize industries. This kind of Catch-22, is one that will require swift and ongoing improvements. "The conversation has to stop being about 'keeping fossil fuels in the ground' and instead become about all the ways that this industry is cleaning up its production[...] Fossil fuels assure the cash flow needed to invest in greener energies. Until 2050, 45% of global energy demand will be met by fossil fuels, so we need to challenge the industry to become cleaner," said Iman Hill, Executive Director of IOGP (International Oil and Gas Producers). Dr. Patrick R. Grubber, CEO of Gevo, added that "agriculture has a bad reputation globally, and many think it is almost as bad as fossil fuels, but this depends on the methods the growers use. If we are producing biofuels, and we care about producing and improving protein, we need to measure the carbon intensity of every unit we sell."

Technology and innovation are ramping up at an exponential pace. Companies that had not fully transitioned into Industry 4.0, that of the digital era, are now having to leapfrog into Industry 5.0, digitization with purpose and an ESG (Environmental, Social and Governance) focus. Accenture decided to coin their own term, Industry X, "as the industrial revolution is accelerating and its stages – 4.0, 5.0 – are overlapping, there is no point in limiting it to a specific number," said the company's Jan-Willem Jannink, Industry X Energy Lead. Communications giant, Telus, has been collaborating with the Canadian government to develop the Federal Sustainable Development Strategy (FSDS). Their goal is "to help them understand how digitization can have a positive impact on climate itself," said Geoff Pegg, Head of Sustainability and Environment.

The green transition will rely on multiple pillars - such as policy, renewable energy, technology, innovation, investments, and mining. Virginie Helias, CSO at Procter & Gamble, has said that "there still is a considerable intention to action gap of about 50%, which means that only half of people who claim they want to live sustainably are actually taking action to do so." Consumers can play a key role by shifting behaviors and choosing the companies they place their confidence in wisely. A successful transition will require all actors working in tandem for a shared outcome.

TRISTAN GRIMBERT
CEO
EDF RENEWABLES NORTH AMERICA

The Inflation Reduction Act will accelerate the deployment of renewables and change the game. Power generation will come at a lower cost, and attention needs to shift towards solutions to manage so many gigawatts (GW) in a way that is compatible with the grid.

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The Promises of Renewable Energy

In 2021, wind and solar generated 10% of global electricity for the first time. The International Renewable Energy Agency (IRENA) disclosed that in 2020, renewables were the cheapest source of energy. As solar and wind stormed the market, the cost of large scale photovoltaic (PV) projects plunged by about 85% in a decade. The global weighted-average cost of electricity for new onshore wind farms decreased from $0.053/kWh in 2019 to $0.030/kWh for the most competitive projects in 2022, without any form of financial support.

BILL SIWEK | PRESIDENT & CEO, TPI COMPOSITES

We are moving toward different resin types that will allow for a fully recyclable blade.

KIM FAUSING | PRESIDENT & CEO, DANFOSS

The global energy crisis is a stark reminder that the need for urgent action requires us to put energy efficiency first.

The Biden Administration's Inflation Reduction Act (IRA), is set to further boost the renewables market in the U.S., financing the installation of 950 million solar panels, 120.000 wind turbines and 2.300 grid-scale batteries by 2030 - an unprecedented effort in American politics that aims to reduce one gigaton of GHG emissions by that same year. Such a bill entails ten times more climate impact than any other piece of legislation ever enacted, and its example will ripple across the globe. Aggressive policy support, heightened societal consciousness and plummeting costs mean the possibility of competitive green energy shines forth as one of the core pillars of the transition.

Singapore will quintuple its carbon tax to

S$25 ($17.28)

per tonne in 2024,
and ramp up to

S$80 ($55.30)

by 2030

TOPI PAANANEN
CEO
PEIKKO

peikko®

Sustainable development needs software development, and we are working on this and showing that the digitization of the industry has arrived.

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PEDRO VASCONCELOS
EXECUTIVE CHAIRMAN
EDPR SUNSEAP

sunseap
by edp renewables

By 2025, one of our aims is to manage beyond the 2 GW installed capacity mark in APAC. The region needs this growth, and it will come from renewable technologies.

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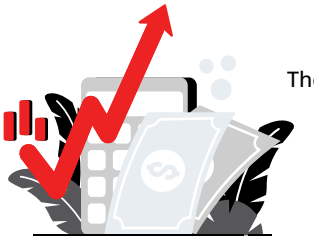

The Inflation Reduction Act will raise

$740 billion

almost half of which is aimed at fighting climate change

Moving our attention up North, in 2021 the Canadian Net-Zero Emissions Accountability Act became law, placing the country's net-zero emissions targets by 2050 at the heart of legislation. Across the pond, the EU is balancing security of supply and a projected harsh winter, against an ambitious 55% reduction in GHG emissions by 2030 and carbon neutrality by 2050 with its REPowerEU strategy. Singapore is not falling short, having announced their Green Plan for 2030 in 2021, with a host of goals in place for the next decade, including the decarbonization of oil and gas, and the chemicals island of Jurong.

A couple decades ago, few would have thought wind and solar energy would become cost-efficient; if anything, they were seen as the subsidized prerogatives of a few Northern geographies. Fast forwarding to 2022, 1 TW of PV energy has been installed globally, which equates to over 6% of the world's total energy consumption – a ramp up that is representative of the wider industry and its explosive momentum, producing around 2000% more energy worldwide than in 2011.

ULRICH LANG
CEO
SMART BLADE

SMART BLADE®

Turbines started growing in size very rapidly but their efficiency was not ideal because of poor aerodynamics - so we focused on making them more efficient.

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EDF renewables

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INNOVATING BECAUSE
THE FUTURE
WON'T WAIT.

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1TW

of solar energy has been installed globally, 6% of the world's total energy consumption

FREDRIK EKSTROM
SENIOR VP, HEAD OF NASDAQ STOCKHOLM

The green transition era will create many opportunities, but there is an important task we all have: to support this change with the help of technology and innovation.

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Despite promising European efforts to ramp up PV production, the East keeps dominating the sector in terms of both demand and panel manufacturing. Ann Mettler, VP of Breakthrough Energy warns that "Europe risks becoming an incubator for the world that does not manifest its achievements in scale[...]In solar, we were an early leader, invested huge amounts into R&D, but today there is not sufficient production."

Eastern regions have one critical advantage; that of cost. Christoph Inglin from Energetix tells us that "the cost of installing solar panels in the U.S. is twice what it is in Singapore." Aided by this major advantage, the 700 square kilometer nation aims to deploy at least 2 gigawatt-peak (GWp) of solar energy by 2030, which is equivalent to powering 350,000 households a year.

Permitting issues and a lack of harmonized policy have been particularly problematic for the development of projects in the wind sector. Even in countries at the forefront of the wind energy industry, permits may take years to be approved, if they are at all. CEO of Swedish wind energy developer OX2, Paul Stormoen, claims that "at times we feel like we are hitting a wall when it comes to getting our projects approved and, all in all, it seems like old environmental laws are hurting the environment more than helping it." Permitting remains a bottleneck, and yet, wind energy production has increased at an astonishing rate in the past few decades. In 1997, installed wind capacity worldwide was 7.5 GW; in 2021, it was over 800 GW, which equates to a growth of more than 100 times in 24 years.

800GW

total installed wind capacity, which grew over 100 times in the past 24 years.

The Journey to Electrification

As utopic as limitless renewable power might sound, the sought after electrified economy is fundamentally reliant upon the grid. Tristan Grimbert from EDF Renewables warns that "we have the GWs, but we cannot currently support development with the current grid infrastructure." Mettler insists that "the grid is the infrastructure that underpins the whole transition[...]it has not received enough attention, both by investors and governments." Peak Power's CEO, Derek Lim Soo, is certain that AI controlled, or 'smart grids' "will be the catalyst to advancing the energy transition, but it will take time to realize a full modernization."

Green energy sources still suffer from weather dependent intermittence, which, without curated management, can cause grid imbalances. If an efficient solution to the problem of storage is achieved, renewables will be in full capacity to deliver. Most battery storage capacity was installed in the last five years, adding up to 16 GW at grid-scale by 2022. Bloomberg New Energy Finance's (BNEF) latest forecasts speak of a 20-fold increase in battery

DIEGO PAVIA | CEO, EIT INNOENERGY
It is not only about innovation, but about creating industrial traction too - only then are jobs created and a real transformation is achieved. 2050 is too far ahead - we can make huge improvements by 2025.

STEFAN OLANDER | CEO, SOLTECH
Sweden's goal is to go from 1% to 10% by 2040 in solar energy development - nothing is brighter than the sun.

capacity by the end of this decade. An alternative and increasingly popular energy storage element is that of hydrogen. With nearly three times the content of gasoline, hydrogen can be stored through electrolysis, and then released by using the gas as fuel in an engine or fuel cell. As the lightest of all elements, it retains a low density at ambient temperature, requiring advanced storage methods.

Oil giants, such as Chevron, have an extensive history working with hydrogen and are tripling their investments by 2028 to develop new energy methods. Jeff B. Gustavsson, President of Chevron's New Energy Division says: "Over an eight-year period, this represents $10 billion – $2 billion going to decarbonizing our traditional oil and gas business, and $8 billion to grow these new businesses." Ashutosh Misra from Air Liquide adds that "hydrogen could account for 20% of the total energy demand of the world over the next 30 years, and will be one of the critical components of the decarbonized energy mix moving forward." ExxonMobil is looking to build a carbon capture hub for their operations and the APAC region. "We have an upstream company that plays to our competitive advantage, because we have the subsurface data, understand the geology, and therefore have a deep understanding to identify the geological formations deep underground that can be suitable to safely store CO_2," said Geraldine Chin, Chairman and Managing Director, ExxonMobil Asia Pacific.

STRATEGIES VOICED BY THE WEST

HEATHER ZICHAL
CEO, AMERICAN CLEAN POWER ASSOCIATION

By 2030, we expect to lower carbon emissions [in the U.S.] by 40% and have around one million people working in the clean energy sector.

ROBERT HORNUNG | CEO, CANREA

Getting to net-zero will require wind and solar to produce more than a third of Canada's electricity by 2050 - in a system twice as big as it is today.

WALBURGA HEMETSBERGER
CEO, SOLARPOWER EUROPE

The EU Commission aims to install 750 GW of solar capacity by 2030, 44% more than initially planned.

GILES DICKSON | CEO, WINDEUROPE

We need to invest in supply chains, get governments to support that and start incentivizing European sourcing and manufacturing.

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When it comes to electrification, Eaton's CEO Craig Arnold says "the tip of the spear is what is happening in the automotive industry with manufacturing these systems at scale." Ralf Pfitzner, Head of Sustainability for Volkswagen, believes the inflection point of EV development and production has already been met: "we anticipate that by 2030, EVs will account for roughly half of our total sales. In Europe, we are already at 70%." Even more ambitious about market potential and customer demand for EVs is Sweden's Volvo, where Head of Advanced Technology and Sustainability, Henrik Green says their "portfolio will be completely composed of EVs by 2030."

CAN THE SUPPLY CHAIN DELIVER?

THOMAS BECKER | CSO, BMW
We have agreements with all our battery suppliers; it does not matter where they are producing, we demand 100% renewable energy sources.

DON BUBAR | CEO, AVALON ADVANCED MATERIALS
There is no shortage of lithium - it is all about finding, refining and turning it into the derivative products needed for batteries.

HELENA HEDBLOM | CEO & PRESIDENT, EPIROC
The technology shifts towards electrification, automation and digitalization will shape the future of mining, helping it transform into a green sector.

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The electrification of the automotive sector requires the charging infrastructure, and that of a grid that can support it. BMW's VP of Sustainability and Mobility Strategy, Thomas Becker points out that buildings "can support charging half a dozen EVs. But once we ramp up to hundreds or thousands, we need to change the electrical infrastructure in our buildings and offices." If there are not enough charging stations the product is rendered useless for the customer, and demand stagnates. For such a wide-spread operation to be actualized, policy needs to enter the playing field.

Mining for Scale

One may feel a bitter-sweet taste when the means for mass clean energy production are right around the corner, yet the infrastructure to underpin it is not yet there and the critical materials to support it need to scale exponentially. Batteries, solar panels, wind turbines, smartphones - they all require minerals. China's stronghold on rare earths and critical metals production is largely attributed to a consistent level of investment and long-term vision, which evolved over several decades. Battery Mineral Resources' CEO, Martin Kostuik claims that "North America, South America, and to an extent Europe itself, definitely have the potential - but not immediately. This potential is not actualized for one simple reason, which is under-investment in the mining industry in the last decades."

Mining for critical metals in North America and Europe remains an incipient stage industry compared to China, but the wheels are set in motion to start planning for a more centralized future. "Rare-earth elements have huge potential for the green transition, from water and food transportation to wind-turbine construction, EVs and so on," says Badrinath Veluri, President of the Rare Earth Industry Association (REIA).

MIDDLE EAST AMBITIONS

FRANCESCO LA CAMERA
DIRECTOR-GENERAL, IRENA

Anything short of radical and immediate action will diminish the chance of staying on the 1.5°C or even 2°C path.

MOHAMED JAMEEL AL RAMAHI
CEO, MASDAR

Masdar has worked closely with Central Asia, Eastern Europe, and Africa. We aim to have 100 GW global gross capacity in the next five years.

RAINER HOEFLING
CHIEF MARKETING OFFICER, BOROUGE PLC

We are taking steps to go into recycling ourselves to be more involved in the circular economy. I view this as our future license to operate.

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Across the board, mining companies are shifting gears to meet global demand for the green transition. The CEO of one of the largest gold mining companies in the world, Mark Bristow from Barrick Gold says "today, about 20% of Barrick's business is copper, but we are looking to double that. When it comes to strategic metals, I consider copper to be the most important of all." Phillips S. Baker, CEO of Hecla Mining, the largest silver producer in North America, adds: "Solar energy is a foundational renewable source, and a technology of which silver is the key component. The positive shift in demand has been mirrored in our production, which has risen by 30% since 2018 and I am expecting a further 30-50% growth over the next five years."

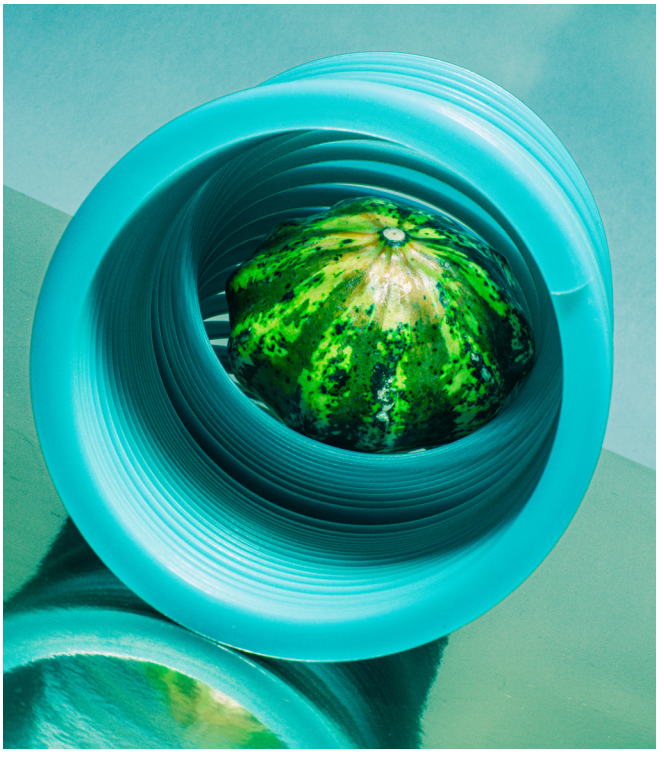
Financial Markets Rise to the Challenge

As we run across the pillars for the green transformation - renewables, battery storage, technology, innovation, and critical materials; one cannot ignore the role that financial institutions and international markets are playing.

The UN forecasts $3 to $5 trillion of investment is needed per year between now and 2050 for the climate transition to be successful. McKinsey sets the target at $9 trillion per year.

One of the greatest challenges faced by companies globally is the lack of international harmonization when it comes to ESG disclosure, which can lead to greenwashing. "Integrating sustainable practices into a company's operations and having good ESG disclosure is key to attracting global capital as responsible investing continues to grow and integrate into the mainstream," says David Arnold, CFO, TMX Group. Now, more than ever, investors are putting pressure on companies to have sustainability and ESG at the forefront of their operations.

Multiple businesses have established their own internal strategies to report ESG, and others have contracted platforms that amalgamate varying standards across continents. But given that an umbrella yardstick has yet to be established, international stock exchanges have risen to the occasion. "A financial market plays an important role in supporting both companies that have made a successful green transition and companies that are still in an incipient phase" said Fredrik Ekstrom, Senior VP, Head of Nasdaq Stockholm. Nasdaq now offers access to the Green Equity Designation for companies whose turnover predominantly stems from green activities, and they have invested in Puro.Earth, a market where companies can use carbon removal credits to offset unavoidable residual emissions.



The Toronto Stock Exchange (TSX) has created an ESG reporting database with IHS Markit, launched The Voluntary Climate Marketplace (TVCM) - which allows companies to purchase carbon credits emitted by green projects, and created the S&P/TSX Battery Metals Index to measure company performance. Larry Lawrence, Head of Sustainable Finance at the U.S. Intercontinental Exchange (ICE) says "within the sustainable finance data organization department, we are bringing capabilities to increase clarity around debt instruments, private companies and their missions, and portfolio profiles. Access to verifiable information such as stats, data, and tools is paramount; it is almost like the marketization of ESG and climate data."

Given the challenges faced internationally, many countries are presently operating in survival mode. "We see global sustainable finance deployment trending lower given significant decline in capital markets, M&A and financing activities, and the focus on inflation control, food, and energy security for communities and countries. While the global commitment to an orderly climate transition remains clear, a pragmatic approach to balance the short-term crisis response and long-term goal achievement is necessary" said Karen Fang, Global Head of Sustainable Finance, Bank of America.

FINAL THOUGHTS

ARIEL PORAT | HEAD OF EUROPE, SIEMENS ENERGY
Energy is one of the highest carbon intensity industries, so we have a lot to do - we cannot do it alone, partnerships are key.

MATS RAHMSTROM | PRESIDENT & CEO, ATLAS COPCO
Companies have realized the importance of ESG for attracting talent as well as investment, not just to tick a regulation compliance box.

PATRIK MOLLER | CEO, CORPOWER OCEAN
The biggest challenge in transitioning to 100% renewables is the balancing; that is where ocean energy can play an important role.

CHRISTIAN HURLIMANN
| RENEWABLES CEO, MET GROUP
Renewable energy technology has matured and is ready for implementation but this will not suffice; we must also remove CO2 from the atmosphere.

BILL T. GROSS | FOUNDER & CEO, HELIOGEN
Batteries are expensive and the world today does not have enough lithium. Instead of storing electrons, we concentrate the sun to 1000 degrees and store it in rocks.

DR. PATRICK R. GRUBER | CEO, GEVO
The idea that we are locked into what has been done in the past is simply not true. We now have economic reasons to drive carbon intensity scores down.

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Aiming at a Moving Target

Consensus remains that climate targets for 2030 remain incredibly ambitious considering geopolitical challenges, supply chain disruptions, inflation, and energy crises are all coming to a climax. At this stage, leaders and companies are juggling a tight-rope to navigate through the immediate obstacles, whilst implementing and developing core competencies, technology and innovation to carry us into the era of sustainability and the circular economy. The green transition itself is not a silver bullet to resolve the world's problems, but rather a necessary step in ensuring humanity's ability to continue inhabiting the world, as closely to what we know it to be today.