Fossil Fuels
Are No Longer Competitive

SOL ABILITY
sustainable intelligence

Summary & Conclusions

Investors, beware: demand for oil is set to decline drastically after 2030

The oil markets & oil business

- The markets for renewables and electricity-powered consumption have reached momentum that is now unstoppable. It's simple economics: Renewables are – by a large margin – more efficient and cheaper.
- Market developments flush more investments in R&D, production and installation - everything renewable and electric will become even cheaper in the near future. The outlook suggests half the cost in the next 10 years, redoubling market dynamics.
- As a consequence, fossils and fossil-powered consumption are no longer competitive. Demand for oil will peak between 2025 and 2027, and therefore start to decline, slowly at first, and faster over time. Demand, revenues and profits for and from fossils will decline in accordance.
- The renewable transition will happen faster than the "mainstream" is currently expecting.
- Demand for oil will decline after 2025. And drastically so after 2030 - even assumed a business-as-usual scenario with no or very limited climate change-forced policies.
- Policies and targets induced by climate change (e.g. incentives and financing framework for renewables, and taxing of fossils) are likely further accelerating market dynamics. It is highly likely that the demand for fossils will be a fraction of todays, and maybe even close to zero by 2040.

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1 Fossil fuels are no longer competitive

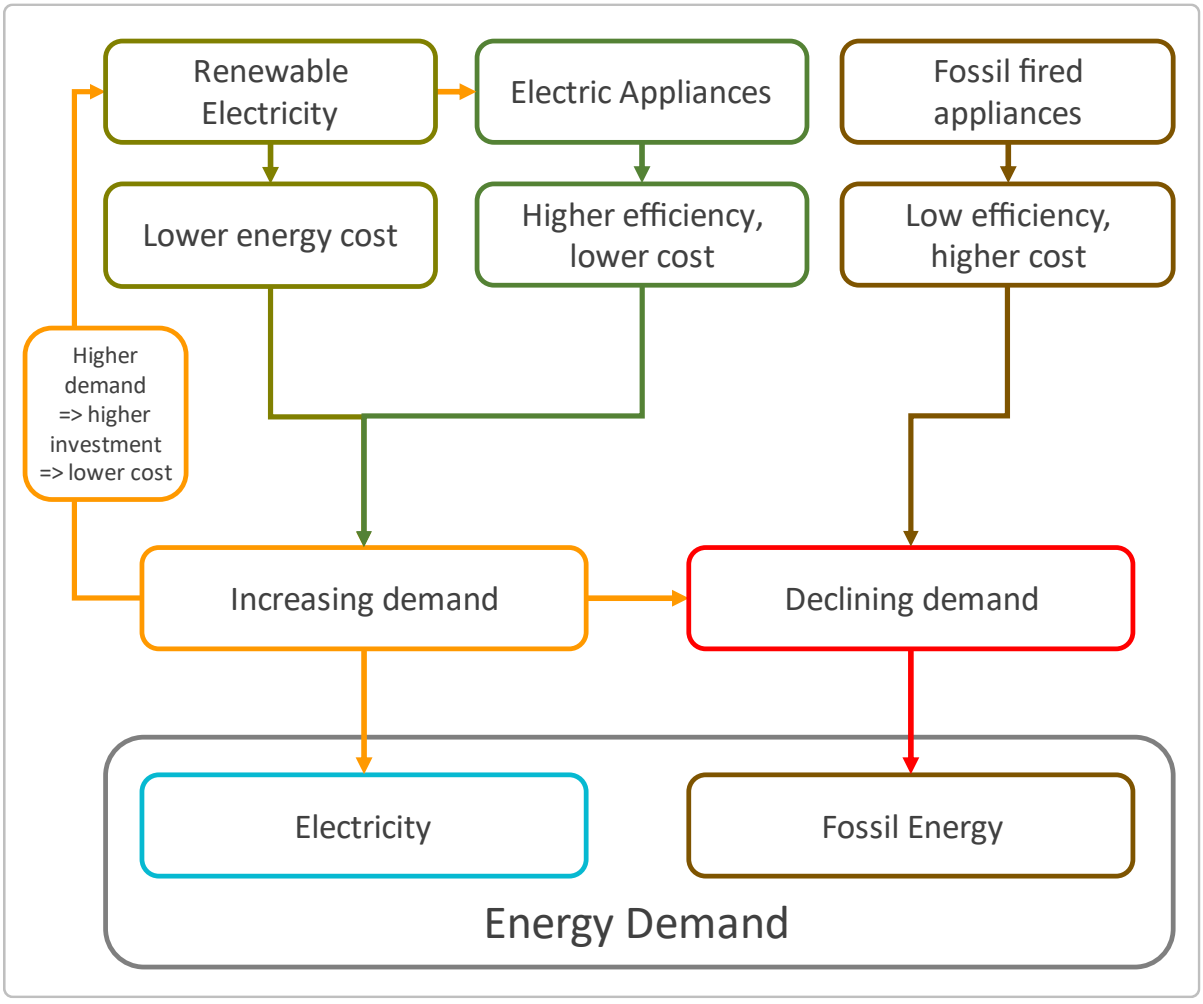
How to replace fossil GDP?

- The IEA predicts that global demand for oil will peak between 2025-2027
- Electric systems (cars, heating) are more efficient and therefore cheaper to operate than fossil equivalent – and electric cars will be cheaper than gasolines in 2025 at the latest
- Solar/wind electricity is now the cheapest source of energy – and is expected to become even cheaper

⇒ **Fossil fuels are no longer competitive**

- **Petro-states (in the Gulf region and elsewhere) currently generate between 20-30% of their GDP from fossils**
- But: revenues and profits from fossils will decline sharply after 2030

The rise of renewables and the decline of fossils



Oil demand is set to decline drastically after 2030

Controlling fire is what in the early stages of evolution distinguished human from other species. It allowed us to survive and thrive in colder climate. Making a fire is age-old technology.

When using fire in technological applications, transforming heat energy to movement, the efficiency is limited by the laws of thermal physics to roughly 35%. Electricity in contrast, has an energy-to-movement efficiency of 100%.

Oil, gas and coal need to be extracted from the ground, and then transported to where the energy is needed. Electricity, in contrast, can be generated everywhere, can be transmissioned through cables, and stored in batteries and kinetic storage.

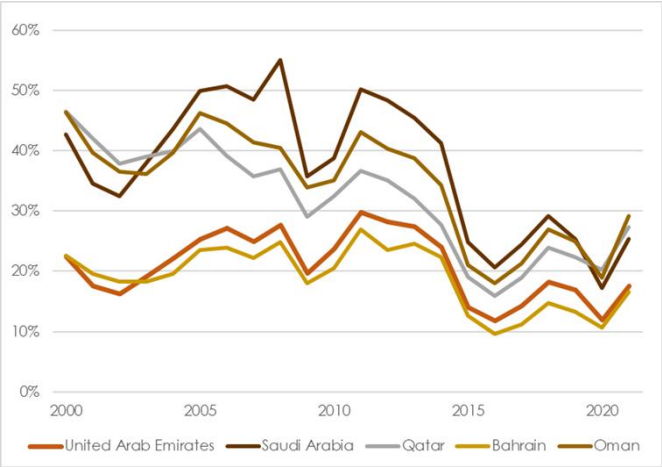
Renewable energy is now the cheapest from of energy in human history – at a cost of 40% of the cheapest form of fossil electricity generation (gas). The efficiency of electric appliances is between 2-5 times greater than fossil counterparts.

Fossil fuels are no longer competitive.

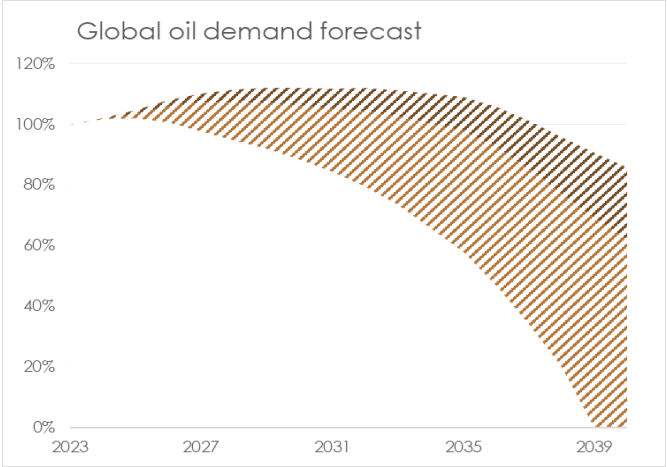
The International Energy Agency (IEA) predicts that global demand for oil will peak between 2025 and 2027 due to cheaper alternatives. When demand starts to decline, prices start to fall. Over-capacity will lead to price competition, further putting pressure on revenues and profit margins.

At the same time, the cost of renewable electricity, batteries, and electric transport and heating systems will further decline, if forecast are to be trusted up to 50% by 2035 – accelerating the decline of fossil demand.

It is highly likely that demand for, and revenues generated from fossils will decline somewhere between significantly and drastically after 2030.



Data source: World Bank
Fossil rent of Gulf area countries as % of GDP



Data source: IEA, BP, SolAbility
Future oil demand estimations

Oil exporting countries generate between significant proportion of national GDP from sales of fossil products. Government revenues are often almost exclusively funded by fossil income. While efforts to diversify the income are underway I some countries, current plans do not allow to compensate for the loss of current income.

Companies in the fossil extraction industry and their suppliers need to completely change their business model or risk being marginalised or disappear.

Renewables & electric appliances:

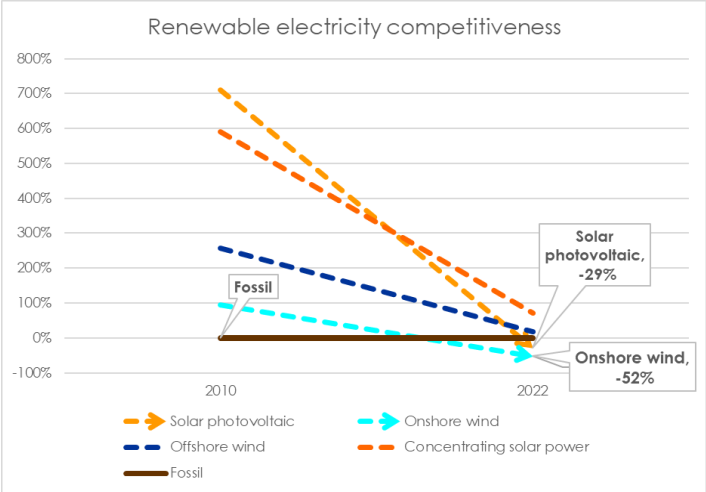
More efficient, less costly

2 Renewable Energy Technology & Cost

2.1 Electricity generation

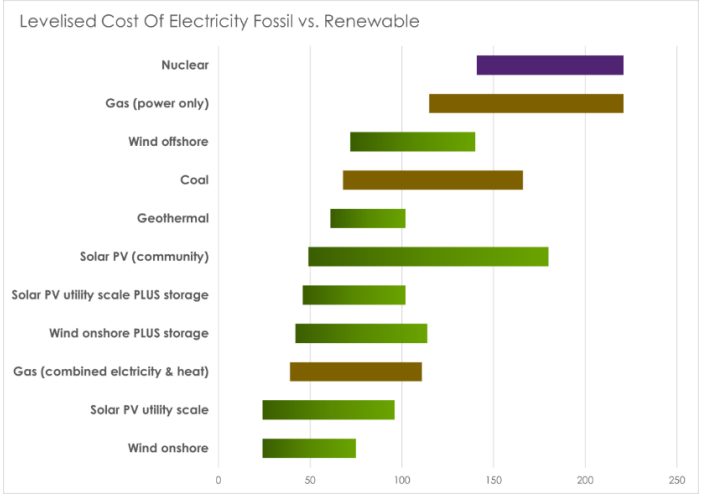
With mass production and increasing demand, cost of renewable energy generation has fallen drastically within the last 15 years. Renewable generated electricity is now significantly cheaper than fossil generated electricity.

Development of electricity generation cost



Data source: IRENA, IEA

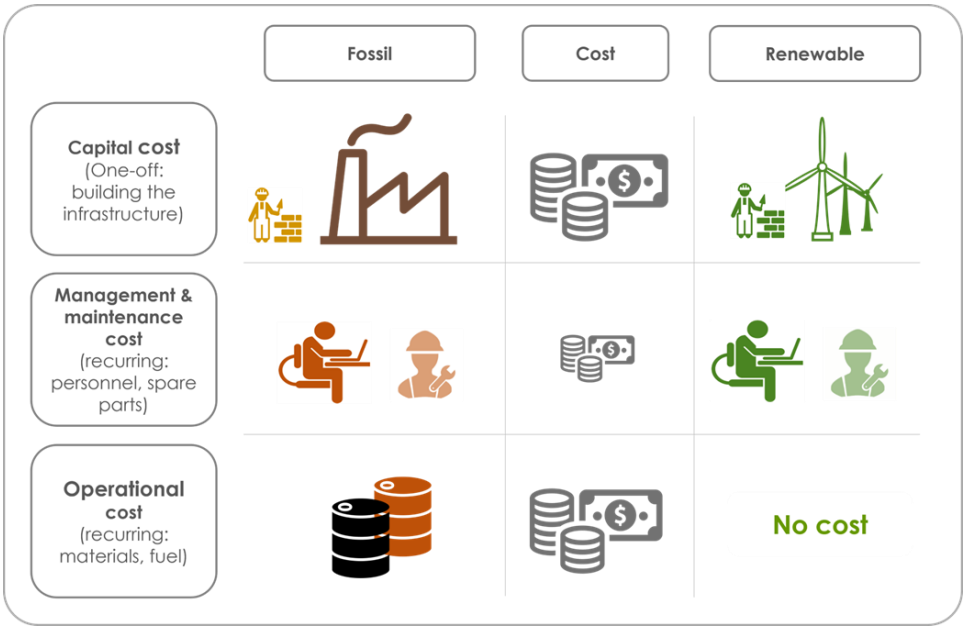
Renewable vs Fossil Electricity Generation Cost



Data source: Lazard, IRENA

- Cost for solar PV has decreased by nearly 800% since 2010; wind electricity by 300%
- New renewable electricity from wind and solar are now less than half the cost compared to the cheapest fossil alternative (gas-fired combined heat/electricity generation)

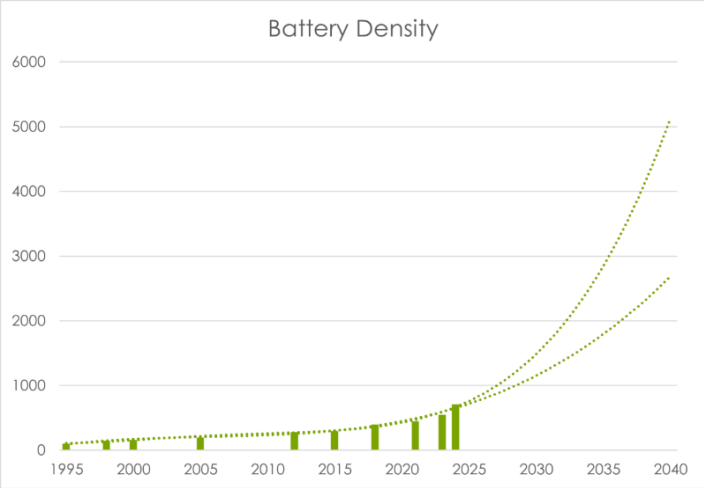
⇒ Fossil electricity generation is no longer competitive



2.2 Electricity storage

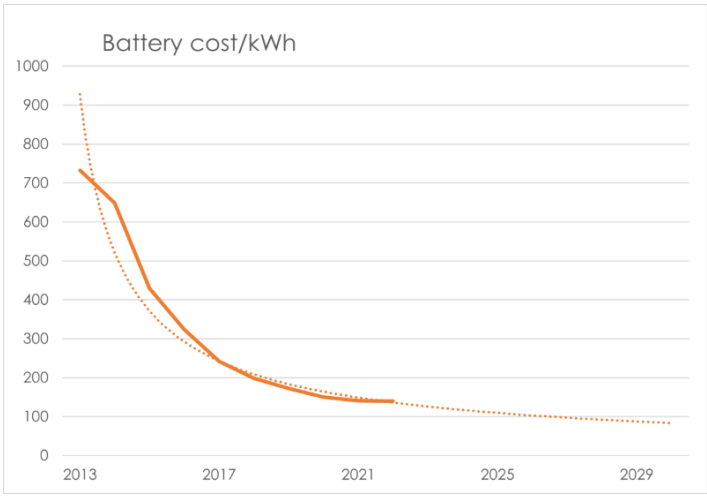
With the increasing use of portable electronic devices (lap-tops, mobile phones) and the electric vehicles, investments in development of battery technology have seen huge budget increases.

The only application currently out of reach remains commercial aviation and seasonal electricity storage in cold climatic environments.



Data source: WRI, RMI, Irena, IEA

A key factor for battery technology is the battery density – the amount of energy/electricity stored per volume/weight of the battery. While the growth of energy density has been almost exponential and is expected to grow steeply in, energy storage capacity will remain below energy density of liquid fuels such as kerosene, making electric commercial aviation unfeasible for the foreseeable future



Data source: WRI, RMI, Irena, IEA

Battery cost have been reduced 4-fold since 2010, Given the global investment push into battery technology, costs are expected to decline further significantly. Making renewable electricity and electric road transport even more competitive.

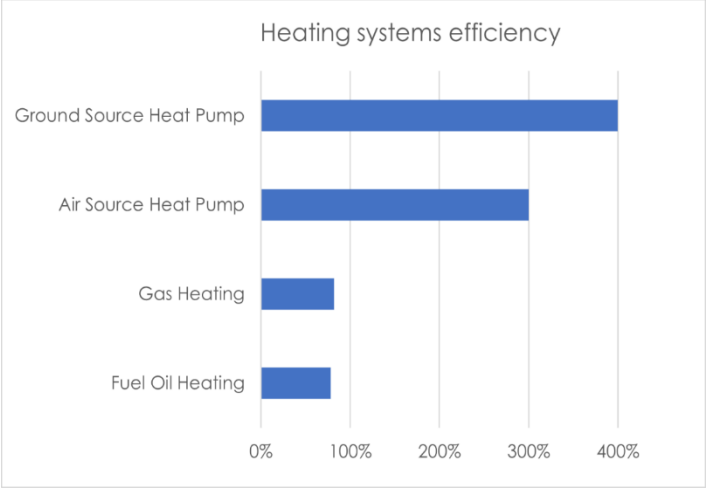
With better technology and increasing production, the cost of batteries has dropped significantly over the past years, and are expected to keep falling even further. Toyota, for example, expects to double density, while halving both weight the cost of batteries before 2027 compared to 2023 levels. By 2030, EVs that are not on the road will be connected to the grid, solving most electricity storage problems (except for seasonal storage).

Electricity storage (compensation for solar/wind down-time) was long considered the bottleneck of renewable electrification. However, battery development trends and learning curves suggest that this is no longer the case, putting further pressure on fossils.

2.3 Heating systems

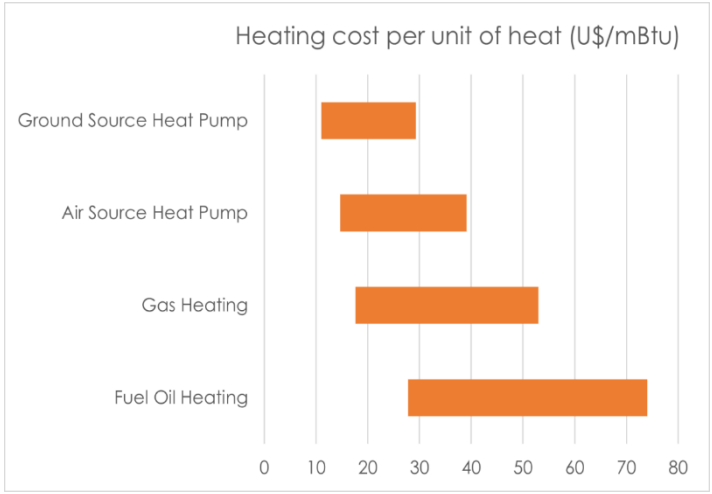
Since humanity learnt to control fire, heat has been provided by fire – wood, coal, and in modern times, oil and gas-powered central heating systems. Heat pumps are comparable new, powered by electricity. Heat pumps do not generate heat energy – the transport heat energy using the temperature differences between two mediums. This process allows a heat pump to generate more energy in the form of heat than the energy input in form of electricity.

The process – transporting heat – can be reversed, meaning a heat pump can also be used as cooling device., eliminating the need for a separate heating/cooling system, further reducing cost.



Data source: Heat Pump Association, IEA

Oil/gas fuelled heating devices generate heat. Heat pumps, in contrast, transport heat energy. Heat pumps are therefore not limited by the energy input. Conventional fuel-fired heating can reach efficiency grades of up to 90%, while the output of a heat pump is up to 4 times the energy input (depending on temperature differences).



Data source: Heat Pump Association, IEA

The operating cost of a heating devices depends on a set of variables – electricity generation cost, taxes and/or tax breaks on fossil energy, and VAT.

In the worst case, heat pump operating costs are comparable to fossil-fired heating systems. Under normal circumstances, heat pump's operating costs are significantly lower due to the higher factor between energy input and energy output.

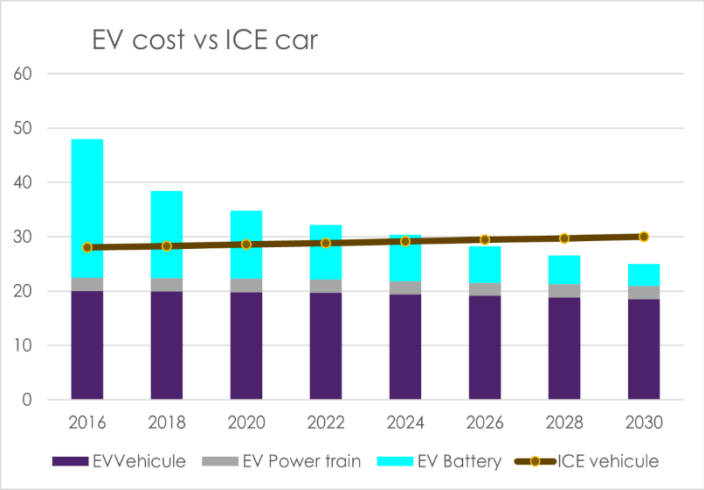
- Heat pumps are more efficient than fossil-fired systems,
- Heat pumps have lower operating cost than fossil heating systems
- Heating pumps can serve as heating *and* cooling devices – eliminating the need and cost for dual systems (separate heating and air-conditioning devices)

Most new installed heating systems are now heat pumps. In many countries, installing heat pumps in new buildings will become mandatory in the near future.

It is not a question if – but only when fossil fired heating system will disappear.

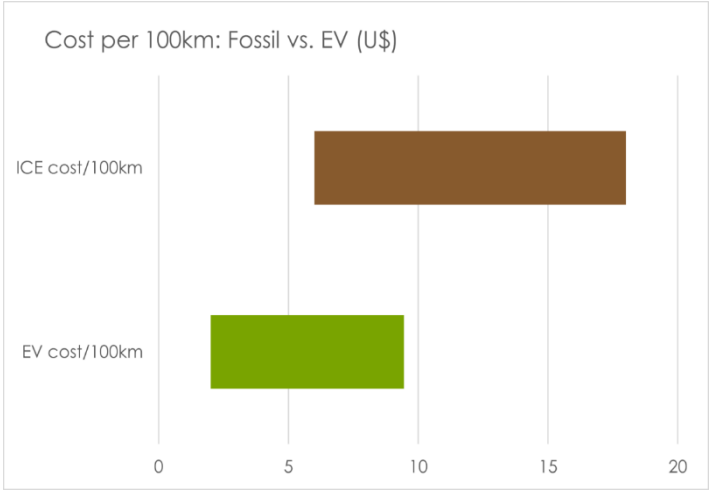
2.4 Road Transportation

Electric cars sales have picked up speed, and already make up the majority of new car sales in selected countries. Due to increasing demand and strategic decisions by car makers, significant vehicle production capacity has shifted towards EV over the last few years.



Data source: RMI, Bloomberg

Electric cars don't need a central engine, no gears and no power train – EVs are simpler in their design construction. However, until recently, high battery costs have been the main cost element of electric vehicles. With sinking battery cost and mass production, electric vehicles have reached market competitiveness vs. fossil fuelled cars – and are expected to be cheaper than fossil counterparts shortly



Data source: RMI, Bloomberg

The efficiency of an internal combustion engine is limited by the laws of thermo-physics, and can reach a maximum of 35%, In ICE cars, between 20-25% of the energy contained in the gasoline is turned into moving energy.

Electric motors directly convert energy to movement, and can reach up to 100% efficiency.

- Purchase price of electricity vehicles will be lower than fossil fuelled cars across the board by 2025/26
- Operating an ICE needs 3-4 times more energy than an electric vehicle.
- Electric cars are significantly cheaper to get from A to B.
- Electric vehicles will make up the vast majority of car sales by 2030

⇒ Fossil-powered internal combustion engine vehicles are the past. The need for fossil gasoline will decline drastically after 2030

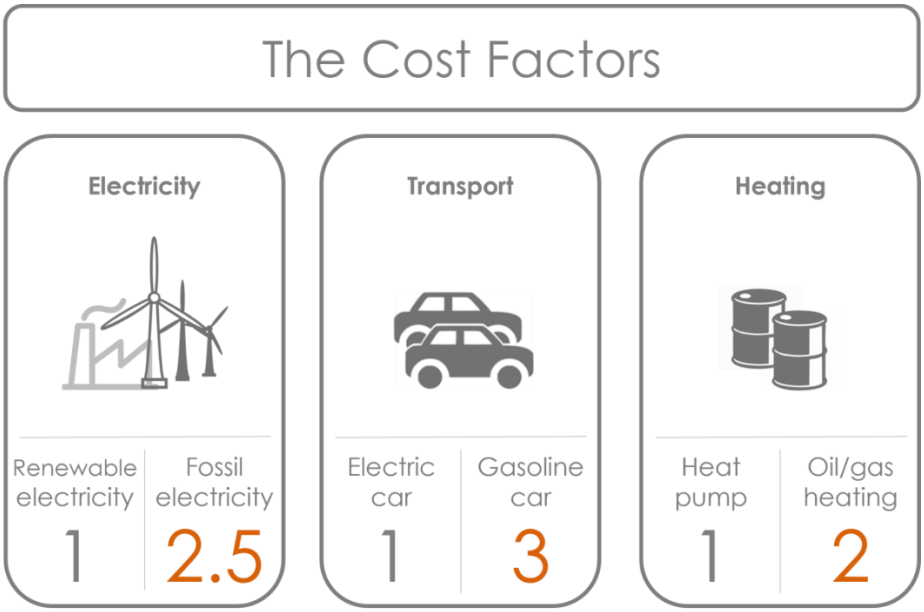
Demand for fossil energy is

Declining

3 Demand for fossils

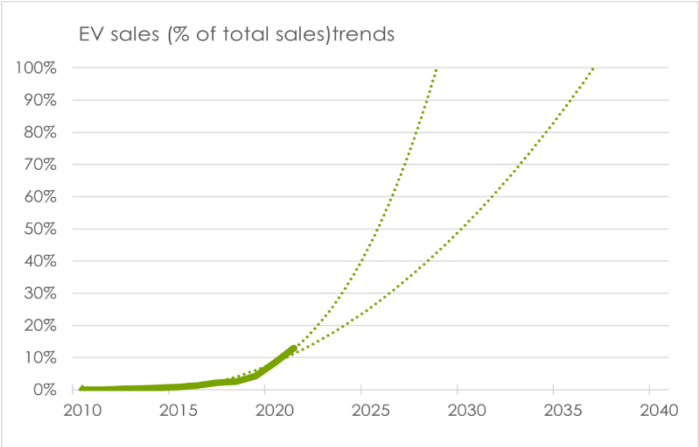
3.1 Where is the money flowing?

Expectations on forecasts on development of renewable technologies and sales of electric vehicles in the past have routinely underestimated growth. The markets always go with the cheapest alternative - despite slow permits, issues regarding regulatory red tape and the heavy subsidises for fossils. The cost question is already answered:



New renewable technology – generation, heating, and transport - is now cheaper than fossil equivalent, by a factor of 2 or more. Investments driven by market dynamics are set to further improve technology and reduce costs in the near future – by around 50% in the next 5 years (batteries) to 10 years (renewable generation). The economic argument is set – and reflected in today's market developments:

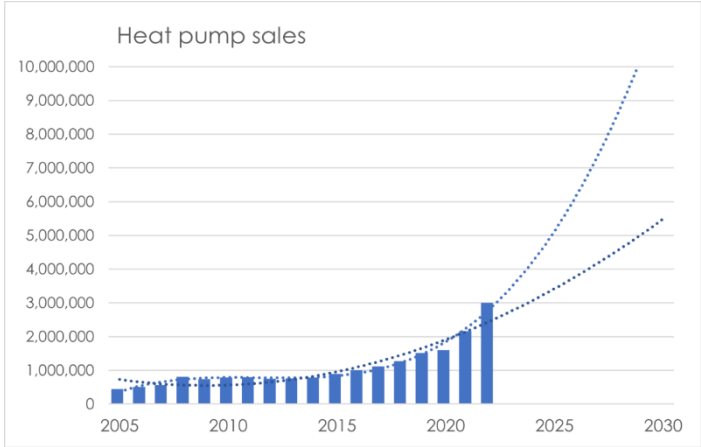
Electric vehicles market share development



Data source: IEA, RMI

EVs have reached almost 20% of newly sold cars in 2023. EVs are reaching purchase cost parity with ICEs in 2024/2025. Not many people will by a gasoline care after that – EVs are expected to reach near 100% of new sales in 2030.

Heat pump sales

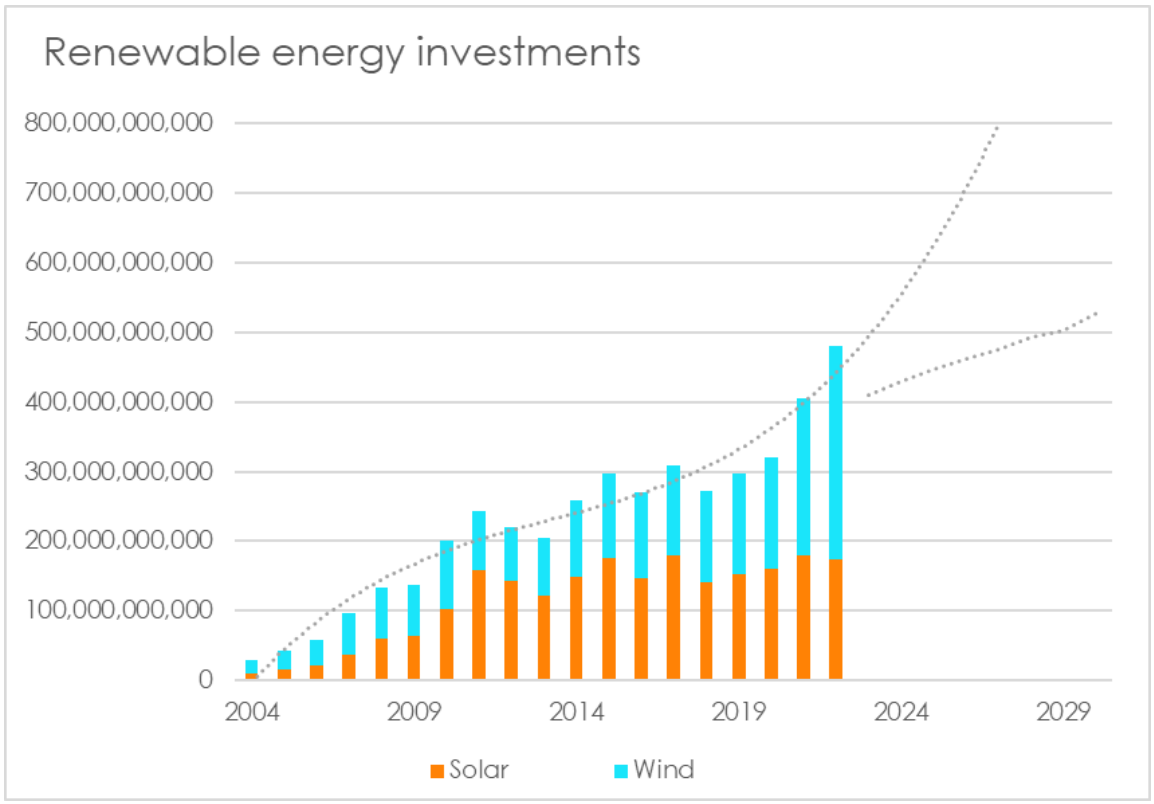


Data source: Heat Pump Association, IEA

Heat pumps are expected to gain near 100% of markets share of new installed systems by 2026/2027

3.2 Renewable investments

The changing cost reality is reflected in international investments in renewable energy generation, both wind and solar PV, with a majority of new electricity generation now covered by renewables. Due to increasing demand for electricity and the lower costs and construction time, Investments in renewables are set to increase further in the future.



Data source: IEA, IRENA

Renewable energy investments have tripled since 2010 – and are expected to continue step increase in the foreseeable future

Renewable energy investments have tripled since 2010 – and are expected to continue step increase in the foreseeable future, both due to market demands for cheap energy and climate change driven policies.

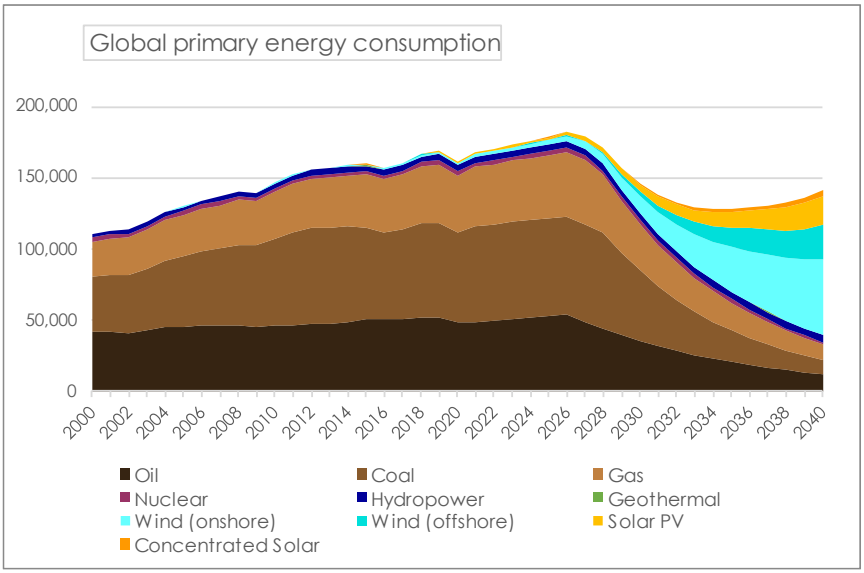
However, the increasing share of renewables is not yet reflected in global CO2 emissions, which are expected to rise by 1% in 2023.

3.3 Future energy mix and climate change policies

Business as usual, conservative:

Under a business-as-usual scenario, the deployment and development of renewables and electricity-powered consumption is expected to start biting noticeably into fossil demand by 2028, accelerating after 2030 due to market dynamics.
It should be note that past projections tended to underestimated the power of economics at the base of the rapid deployment of renewables.

Data source: historic data by IEA, BP, IRENA. Simulation by SolAbility based on projections by IEA, IRENA

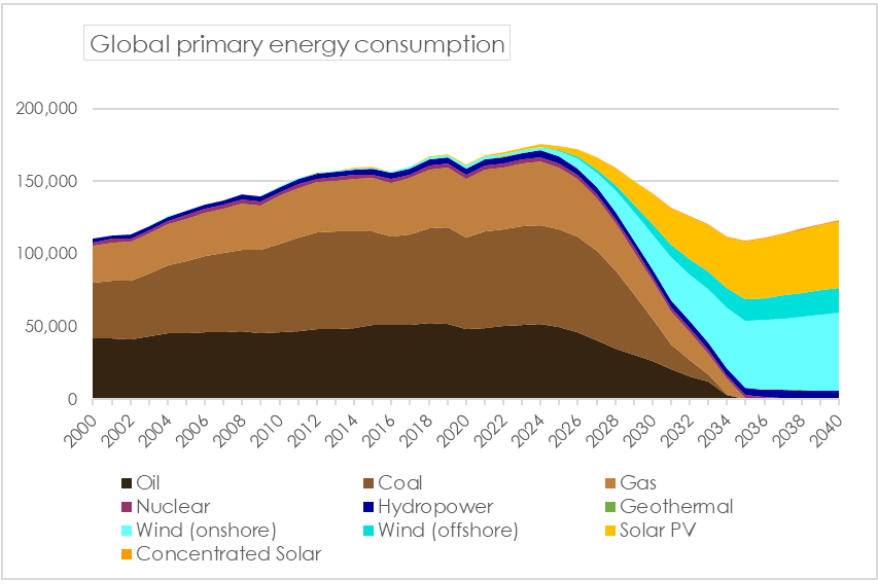


If business-as-usual persists, this is the future energy mix, showing step decline of demand for fossils and availability of renewables after 2030; demand for fossils would be at app. 25 % of current demand by 2040. This simulation is based on effective current cost and financing, with conservative estimations of future cost of the new & renewable technologies and financial flows. Market dynamics are difficult to predict. Most likely, market dynamics are going to significantly accelerate the transition away for fossils and combustion towards the less costly renewables and electric-powered consumption as compared to the BaU scenario.

Including climate policies

Future energy mix projection taking into account potential policies combatting climate change. The proportion of fossil energy is expected to start decline after 2026, with accelerating pace of deployment of renewables after 2028. Depending on the quality of climate policies (incentive and financing frameworks for renewables, taxing of fossils), renewables will cover 199% of all energy needs between 2032 to 2037

Data source: historic data by IEA, BP, IRENA. Simulation by SolAbility based on projections by IEA, IRENA



This is how the future energy mix looks if humanity were to be serious about its own survival. Using today's technology and the application of basic economics on a global scale, renewables could power the World economy by 2035 – i.e. eliminating demand for fossils by 2035. Global co-ordination to counter global warming seems unlikely at this point but cannot be excluded. Demand for fossil is therefore expected to decline even faster – asking even bigger questions off the oil-producing states and companies.

3.4 Declining oil/gas/coal demand

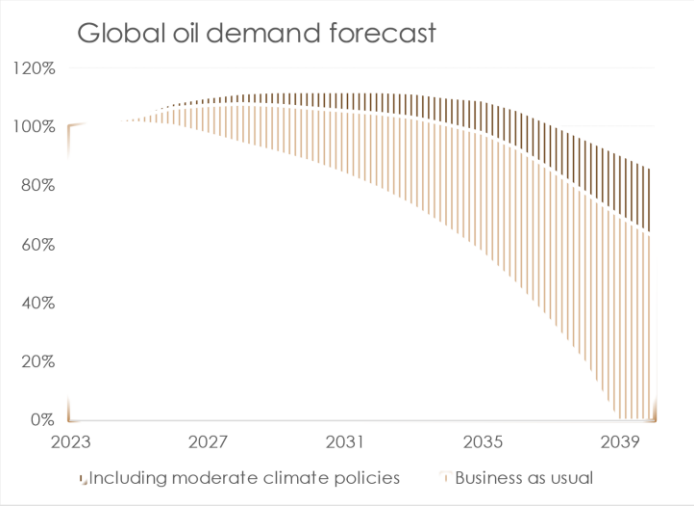
As set out before, renewables are now the cheapest form of energy, and electric systems – road transport, heating - the cheapest for everything that requires energy in real life. Renewable technology is superior both in terms of physical efficiency and financial cost. On top of the economic deficit of fossils, policies in response to global heating are highly likely to further impact the energy markets – by removing the fossil subsidies or taxing of fossils, and market incentives in favour of renewables.

Fossil fuels can no longer compete.

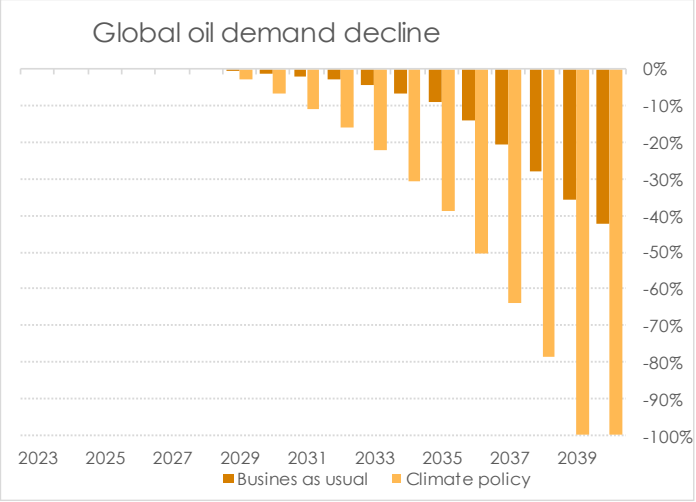
Future investments from main-stream capital resources– both from the markets and fiscal resources – is therefore going to flow towards new renewables and electricity.

Simulations indicate that – under a very conservative business-as-usual scenario - demand for fossils will decline by 40% by 2040, even without any climate change-related policies. More realistic seems a combination of market forces and renewable incentive policies as response

to the accelerating global heating. Government policies – through elimination of fossil subsidies, policy incentives (tax breaks, integrated planning, credit guarantees, R&D, fossil taxes) will massively accelerate private investments. Even moderate climate policies could eliminate almost the entire demand for fossils by 2040.



Historical data: IEA, BP; future projections by SolAbility



Historical data: IEA, BP; future projections by SolAbility

- **Assumed an - unlikely – conservative scenario, demand for fossils will decline by 40% by 2040**
- **Factoring in global warming response policies, fossil demand could be almost completely eliminated by 2040**

Regardless of how fast and how big the decline will unfold – the decline of fossil demand is inevitable.

This, in turn, ask questions of all countries and players that are generating their company and government revenues from the sale of fossils.

3.5 Oil dependency

Assumed an - unlikely – conservative scenario, demand for fossils will decline by 40% by 2040

Factoring in global warming response policies, fossil demand could be almost completely eliminated by 2040

Petro-states

The expected decline in demand for oil and the subsequent draining up of fossil revenues, will lead to a decline in income countries that rely on the sale of fossil products – if not addresses in timely manner (now, that is). They therefore need to reconsider their approach to development and particullarely, their investments. While a number of oil-exporting countries have issued visions, have developped concepts, and are activly invsting in cenpets beyond the exploitation of fossils, none of these countries currrently seem in line to replace their respective fossil income in the time-frame required to maintain current GDP levels. More, and faster, is required.

By 2040 at the latest (better 2035), countries that generate income and/or government revenues from the sales of fossil products on the global markets need to replace a significant proportion of the GDP, and their government revenues by different sources of income if they want to avoid a decline in standard of life.

The oil-gas-coal industry and the financial markets

The core market of the business of fossil companies is set to basically be eliminated. With falling demand, there will be overcapacities and many players fighting over a shrinking market. It is the basics of demand and supply: not only revenues, but also profit margins are set to decline. If companies active in the extraction of fossils – as well as all their suppliers - fail to adapt to the declining external market demands and change their business models, they will be marginalised or disappear.

Given the current market outlook, the oil industry and oil-producing countries can expect between 2-5 "fat" years for the (as of 2023). After that, revenues and profit margins will decline.

We will soon find out if the CEOs of fossil companies are worth their salaries.

Declining revenues will affect market value and share prices of companies in the fossil industry. Investors should pay particular attention.

Conclusions

The Oil markets & business

- The markets for renewables and electricity-powered consumption have reached momentum that is now unstoppable. It's simple economics: Renewables are – by a large margin – more efficient and cheaper.

- Market developments flush more investments in R&D, production and installation - everything renewable and electric will become even cheaper in the near future. The outlook suggests half the cost in the next 10 years, redoubling market dynamics.

- As a consequence, fossils and fossil-powered consumption are no longer competitive. Demand for oil will peak between 2025 and 2027, and therefore start to decline, slowly at first, and faster over time. Demand, revenues and profits for and from fossils will decline in accordance.

- The renewable transition will happen faster than the "mainstream" is currently expecting.

- Demand for oil will decline after 2030, even assumed a business-as-usual scenario with no or very limited climate change-forced policies.

- Policies and targets induced by climate change (e.g. incentives and financing framework for renewables, and taxing of fossils) are likely further accelerating market dynamics. It is highly likely that the demand for fossils will be a fraction of todays, and maybe even close to zero by 2040.

There are some questions being asked of oil-exporting countries and companies in the fossil energy industry

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About this Report

Methodology, data gathering, calculation, & report compilation by SolAbility.

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SolAbility Sustainable Intelligence
Zurich, Seoul
www.solability.com
contact@solability.com

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