Climate Action Tracker

Scaling up climate action

Key opportunities for transitioning to a zero emissions society

FULL REPORT

CAT Scaling Up Climate Action series

INDONESIA

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CAT Scaling Up Climate Action series

The Climate Action Tracker (CAT) strives to support enhancing climate action in the context of the Paris Agreement implementation. This analysis contributes to future revisions of mitigation targets, and aims at spurring an increase in climate mitigation actions, to close the gap between current emissions projections and required Paris-compatible pathways.

As part of this, we have been researching the potential for countries to scale up climate action in different focus areas. The analysis in this report is relevant to Parties considering revisions to their Nationally Determined Contributions (NDCs) to be submitted under the Paris Agreement by 2020, and also to their submission of long-term low greenhouse gas development plans, also due by 2020.

The result is our **Scaling Up Climate Action** country series, which identifies options for increased sectoral action that would move a country towards a pathway compatible with the Paris Agreement's long-term temperature limit and estimates the impact of those actions on emissions and other benefits.

The first round of our analysis covers **South Africa**, the **European Union**, **Argentina**, **Indonesia**, **Turkey** and **Australia**.

The consistent method and similar structure for all six reports allows for country-specific insights, while enabling a cross-country comparison to draw general research findings and lessons learnt on global potentials.

climateactiontracker.org/publications/scalingup

Executive summary

Introduction and objectives

Under the Paris Agreement, governments have committed to limiting temperature increase to well below 2°C above pre-industrial levels and pursuing efforts to limit it to 1.5°C. Current efforts are insufficient: aggregate mitigation targets for 2030, according to Climate Action Tracker (CAT) estimates, result in global warming of about 3.0°C. Implementation of the targets is falling short, with greenhouse gas (GHG) emissions under implemented policies leading to an estimated warming of around 3.3°C.

To stay below the globally agreed limit, the IPCC Special Report on 1.5°C finds that an increase in efforts is required to peak global GHG emissions as soon as possible and reduce CO_2 emissions to net-zero around 2050 and total GHG emissions shortly thereafter.

We no longer live in a world where climate change mitigation is a burden per se, but where it increasingly becomes the most feasible option when considering all socio-economic aspects. For cost-efficient global mitigation, it will be essential to make those mitigation actions accessible to, and overcome remaining barriers in, all countries.

This report, the fourth country assessment in the Climate Action Tracker's Scaling Up Climate Action Series, analyses three key areas where Indonesia could accelerate its climate action: electricity supply, passenger ground transport and forestry. The report illustrates GHG emissions reductions from such actions, along with other benefits for sustainable development.

Our analysis begins with an in-depth review of Indonesia's current policy framework and sectoral developments, comparing them with the policy packages and the sector indicators required under 1.5°C-compatible pathways.

We then focus on three areas we have identified that have a large potential to increase mitigation efforts: electricity supply, passenger road and train transport, and forestry. They were selected based on their share of GHG emissions and considering national and local circumstances. The CAT emphasises that other sectors must also take similarly ambitious actions to decrease economy-wide emissions in line with the Paris Agreement

Finally, we identify different options of accelerated climate action in each sector informed by insights from three categories of scenarios: (1) national research and country-specific studies (*national scenarios*), (2) practices implemented by regional or international frontrunners (*best-in-class scenarios)*, and (3) sectoral developments in line with the Paris Agreement's long-term temperature limit (*1.5°C Paris Agreement compatible scenarios)*.

	Scenario categories	Definitions
1	NATIONAL SCENARIOS	Scenarios based on national research and country-specific studies
2	BEST IN CLASS SCENARIOS	Scenarios based on practices implemented by regional or international frontrunners
3	1.5°C PARIS AGREEMENT COMPATIBLE SCENARIOS	Scenarios based on sectoral developments in line with the Paris Agreement's temperature limit.
4	CURRENT DEVELOPMENT SCENARIO	Baseline scenario used for comparison purposes. The scenario is based on the continuation of current trends and policies until 2050.

KEY FINDINGS

- ⇨ Scaling up climate action in the electricity supply, passenger ground transport and forestry sectors, which together covered about 70% of Indonesia's emissions in 2014, would lead to curbing emissions growth and could achieve a 20% *reduction* in emissions below 2010 by 2030. This stands in stark contrast to the currently projected 58-68% emissions *increase* under Indonesia's Paris Agreement Nationally Determined Contribution (NDC). It would initiate Indonesia's transition towards zero emissions in line with the Paris Agreement and peak Indonesian GHG emissions excluding deforestation and land use shortly after 2030.

Electricity supply

- ⇨ To bring Indonesia in line with the Paris Agreement and with full decarbonisation of the power sector by 2050 requires a share of decarbonised electricity generation of 50–54% by 2030, with no new coal plants and coal phased out by 2040. The most promising way to full decarbonisation is for Indonesia to prioritise developing renewables to make up a share of around 50% by 2030 and 100% by 2050. Such a pathway would deliver the greatest societal benefits and avoid large-scale early retirement of new coal-fired power plants.
- ⇨ Decarbonising power is paramount to decarbonising other economic sectors. Electrifying Indonesian transport will only result in sufficiently large emission reductions when the domestic power supply is decarbonised.
- ⇨ Ambitious climate policy in the Indonesian power sector can yield substantial employment benefits: development of solar PV will play a central role in a future low-carbon electricity system and our most ambitious renewables deployment scenario could create, on average, up to 290,000 additional direct jobs between 2020 and 2030.
- ⇨ Job losses in the domestic coal supply chain (after 2025) are expected to be largely outweighed by additional new jobs in building and operating new renewables capacity. This shift will require preparation now to ensure a Just Transition.

Road and rail passenger transport

- ⇨ As Indonesia's GDP grows, passenger transport demand is expected to grow substantially until 2030, by around 3% annually. Fuel economy standards, developing public transport and introducing electric mobility are key measures to start decreasing passenger transport emissions in the short term.
- ⇨ Strong electrification of the passenger vehicle fleet, coupled with decarbonised electricity would enable decarbonisation of passenger transport and be in line with requirements of the Paris Agreement. Our most ambitious scenario assumes 100% electrification of the passenger vehicle fleet by 2050. Such an achievement would require going beyond, and sustaining, existing global best practices, e.g. the recent uptake of electric two-wheelers seen in China.
- ⇨ These measures carry important co-benefits such as improving local air quality and reducing congestion in cities.
- ⇨ Indonesia has a very ambitious biofuel blending policy. Biofuels could play a significant role in decarbonisation of the transport sector, although without additional measures related to governance and sustainability certification, palm oil biofuel production will continue to drive deforestation as oil palm plantations expand into Indonesia's primary forests.

Forestry

- ⇨ Although ambitious interventions in all sectors are urgently needed to prevent fossil fuel lock-ins, the Indonesian forestry sector, with globally significant emissions peaking at 1.6 $GtCO_2e$ in 2015 (because of very high peat fires in that El Nino year), has the single largest potential for reducing domestic emissions.
- ⇨ Indonesia can turn its forestry sector into a net sink of carbon emissions by 2030 if (1) it stops peat fires by 2020, (2) it drastically reduces or even phases out emissions from peat degradation via peat restoration by 2030 and (3) it ensures that emissions from deforestation are net-zero by rapidly reducing deforestation rates and reduce deforestation to almost zero by 2040, as well as mounting ambitious afforestation/reforestation programmes. This is more ambitious than Indonesia's NDC pledge under the Paris Agreement for the forestry sector.
- ⇨ The 2015 peat fires in Indonesia have created political momentum to address this large source of emissions. But sub-national governments require more support to manage diverging interests among stakeholders, and land-swapping schemes for peatlands under concession require revisions to better meet all stakeholder needs. Its success would bring major co-benefits in avoided health impacts, environmental degradation and economic damage.

Sector transitions towards zero-carbon

Limiting global temperature increase to 1.5°C is highly relevant for Indonesia as, at 3% of global emissions (incl. LULUCF), it is among the world's largest greenhouse gas emitters and expected to be among the worst affected by climate change.

Recent research suggests that climate change has multiple adverse effects for Indonesia, including an increase in surface run-off, extreme low and high-river flows, severe droughts and at least 50 million people exposed to the effects of sea level rise. If it doesn't take sufficient domestic mitigation and adaptation measures, Indonesia will also suffer from more frequent forest and peat fires, which, besides emitting large amounts of greenhouse gases, are also an environmental and public health hazard.

Recent developments in Indonesia and projected trends cast doubt on whether Indonesia will achieve sufficient mitigation to meet the Paris Agreement long term temperature goal. If Indonesia continues on its current path without taking any further climate action, the country's GHG emissions are projected to double by 2030 from 2012 levels. This highlights the importance of decreasing the carbon intensity of key sectors to decouple CO_2 emissions from population and economic growth and reduce the country's dependence on carbon intensive fuels, in particular coal.

In recent years, measures to reduce GHG emissions have, in many cases, become more attractive globally to policymakers and private investors, both because of falling technology costs, as well as increased awareness of the negative impacts to be avoided and other positive benefits of mitigation measures such as air quality improvement and job creation from zero-carbon technology and infrastructure development.

In Indonesia, there is tremendous potential to scale up climate action, especially in the focus areas of this study: electricity supply, passenger transport, and forestry.

Increasing climate action now would initiate technically-feasible and socio-economically beneficial sectoral transitions towards a zero-emissions society while directly benefitting Indonesia's sustainable development agenda.

Our findings confirm that ambitious decarbonisation efforts in the Indonesian electricity supply, passenger transport and forestry sectors would significantly reduce greenhouse gas (GHG) emissions while simultaneously fostering co-benefits such as job-creation, reducing air pollution, reducing peat fires, conserving biodiversity, reducing traffic congestion in urban centres, promoting resource independency and increasing electrification of remote areas.

Electricity supply

To meet the Paris Agreement temperature goal, coal-based **electricity** generation is expected to halt its current expansion and then be reduced drastically. But in in the coming decade in Indonesia, power demand is expected to double, and additional capacity to meet such demand is planned to be predominantly based on coal-fired power stations from domestic coal production, completely at odds with the Paris Agreement.

Such plans are mainly due to recently-strengthened efforts to reduce fuel imports and become more energy independent. Other influencing factors are (1) the importance of revenues from coal mining in the state budget and for provinces, (2) the dominance of incumbents, and (3) the significant new funding for fossil fuel infrastructure that is being channelled to Indonesia by major Asian economies such as Japan, South Korea and China.

A swift energy transition in Indonesia is essential to be compatible with effort levels required to limit global warming to 1.5°C below pre-industrial levels. This will require a major trend shift. Additional power capacity needs to meet rapidly rising electricity demand represent both a challenge and an opportunity: by supporting the development of renewables (which are increasingly becoming cheaper than coal), Indonesia can develop more resilient grids and reduce air pollution.

Besides showing that the energy transition required to limit warming to 1.5°C will have significant benefits for access to clean and affordable energy and poverty eradication goals, the IPCC Special Report on 'Global Warming of 1.5°C' also re-emphasised that globally, coal needs to exit the power sector by 2050, a finding that has important implications for short and medium-term policy in Indonesia to avoid a high risk of stranded assets.

Indonesian research organisations' scenarios (referred to as the "national scenario" in this report) with the highest shares of renewables in the power supply foresee the potential for the share of renewable electricity to rise to 74% by 2050, and GHG emissions for electricity generation to drop by up to 66% below 2012 levels in 2050.

However, our analysis suggests that to be Paris Agreement-compatible and reach complete decarbonisation by 2050, the most promising option is to fully transition the electricity sector to 100% renewable sources. Indonesia is well-endowed with a range of renewable energy sources, while deployment of nuclear power or fossil fuels with CCS is highly unlikely, and not considered a realistic option to decarbonise electricity generation.

Other alternative low-carbon technologies are not expected to compete economically with renewable energy and storage where costs are falling and are expected to continue to fall. Renewable energy also presents large co-benefits related to economic development and health.

On the way to 100% renewable power in 2050, Indonesia should aim for 50% renewables in the fuel mix by 2030. This is a much higher share than the 20% by 2027 currently envisaged in the ten-year plan published in 2018 by Indonesia's state-owned transmission system operator, Perusahaan Listrik Negara (PLN), and the 23% by 2025 targeted by the government in the Electricity Supply Business Plan (RUPTL)[1]. Aiming for 50% renewables by 2030 would imply replacing the 27 GW of additional coal-based electricity generation planned in the next ten years with new variable renewables (especially solar PV and wind) as well as upgrading the grid

[1] In March 2019, the 2019 RUPTL was published. This was beyond the cut-off date for this report, but the Electricity Supply Business Plan shows similar levels of renewables deployment as that of the year before. Total coal capacity additions are similar as in previous plans, however the 2019 RUPTL frontloads coal capacity additions to the next years.

infrastructure. This implies a peaking of power sector emissions around 2025, representing a reduction of 20% below current policy projections by 2025.

To achieve such a transition, Indonesia would need to reduce its reliance on coal, and stop building new coal fired power generation to avoid the challenge of stranded assets, as coal would have to be phased out for power generation by 2040. This transition would have to be carefully managed to address the current importance of the sector for revenues at regional and local level.

Existing regulations, buoyed by fossil fuel interests, are too weak to stimulate the uptake of the vast renewable power potential in Indonesia. Increasing investor confidence by revising regulations on renewables' support would be a good first step. Recent changes to risk allocation in power purchasing agreements and to the feed-in-tariff scheme have had a negative impact on investors' ability to plan. The transition would imply fewer jobs in the coal industry, but this would be more than compensated by more jobs in renewables (see below).

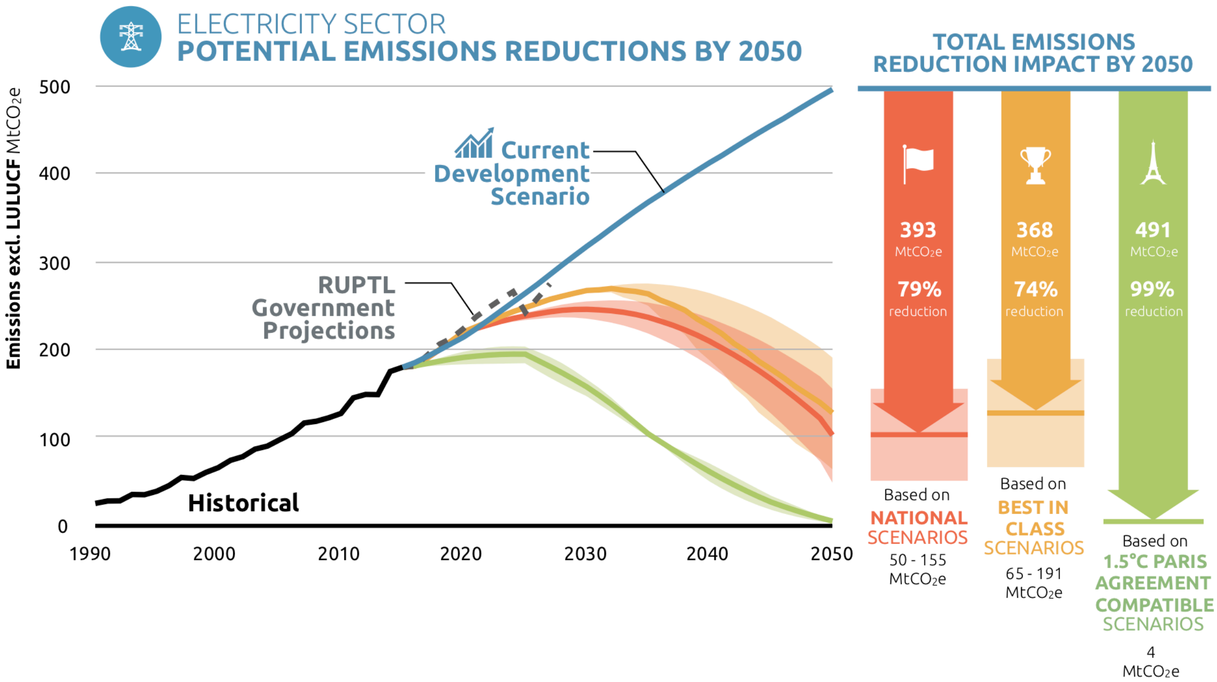


Figure 1: Overview of sectoral emission pathways in the Indonesian electricity sector under current policies and different levels of accelerated climate action. The projected electricity demand also considers accelerated climate action in the Indonesian passenger transport sector. All sectoral historical emissions and projections towards 2050 are analysed in the CAT PROSPECTS Indonesia scenario evaluation tool.

Passenger road and train transport

In a country with expected high economic and urbanisation growth, **passenger transport** is another sector key to achieving the Paris Agreement target. Growth in transport-related fossil energy demand will negatively impact emissions, but also comes with other challenges such as health impacts and congestion, especially in the country's growing cities.

There is significant potential for national and sub-national actors to accelerate climate action by successfully decarbonising key sub-sectors such as passenger transport. Road and train transport systems can be transitioned through the implementation of public mass transport (e.g. bus Mass Rapid Transport system in the Jakarta region or measures to limit the number of cars in city centres) and the electrification of all vehicles (mainly cars, buses and two-wheelers but also trains such as the long distance high speed railway project being developed between Jakarta and Bandung).

Our analysis shows that short-term measures - such as fuel standards and development of public transport - are key to balancing the expected rapid growth in transport demand due to motorisation and economic/demographic growth. Indonesia also has a very ambitious 2025 biofuel blending policy, explaining the shape of the curve of the national scenario in the figure below.

Biofuels could play a significant role in decarbonisation of the transport sector, but palm oil biofuel production is causing adverse effects as it has been a driver of deforestation, with oil palm plantations expanding into primary forest in Indonesia. Additional measures related to governance and sustainability certification are required for the biofuel mandate to have a positive environmental and climate impact. If such measures are taken, biofuel blending growth could be extended until 2030 in most ambitious scenario.

Incentive programmes for hybrid vehicles and Indonesia's potential ban on fossil-fuel car sales by 2040 are a first step on the path toward achieving transport sector decarbonisation. To achieve the required level of emissions reductions in the long term, strong electrification of the passenger vehicle fleet is needed starting today. This means going beyond, and sustaining, existing global best-in-class examples (e.g. historical electric cars development in Norway or recent uptake of electric two-wheelers in China) which our assessment shows could achieve 65 to 80% emissions reduction in 2050 compared to the Current Development Scenario.

Electric vehicles also have the potential to provide flexibility to the power sector and therefore also help in the integration of additional variable renewable capacity. Electrification will also help to decrease the reliance on oil imports and achieve important benefits for sustainable development by reducing air and noise pollution as well as congestion impacts in Indonesia's growing cities.

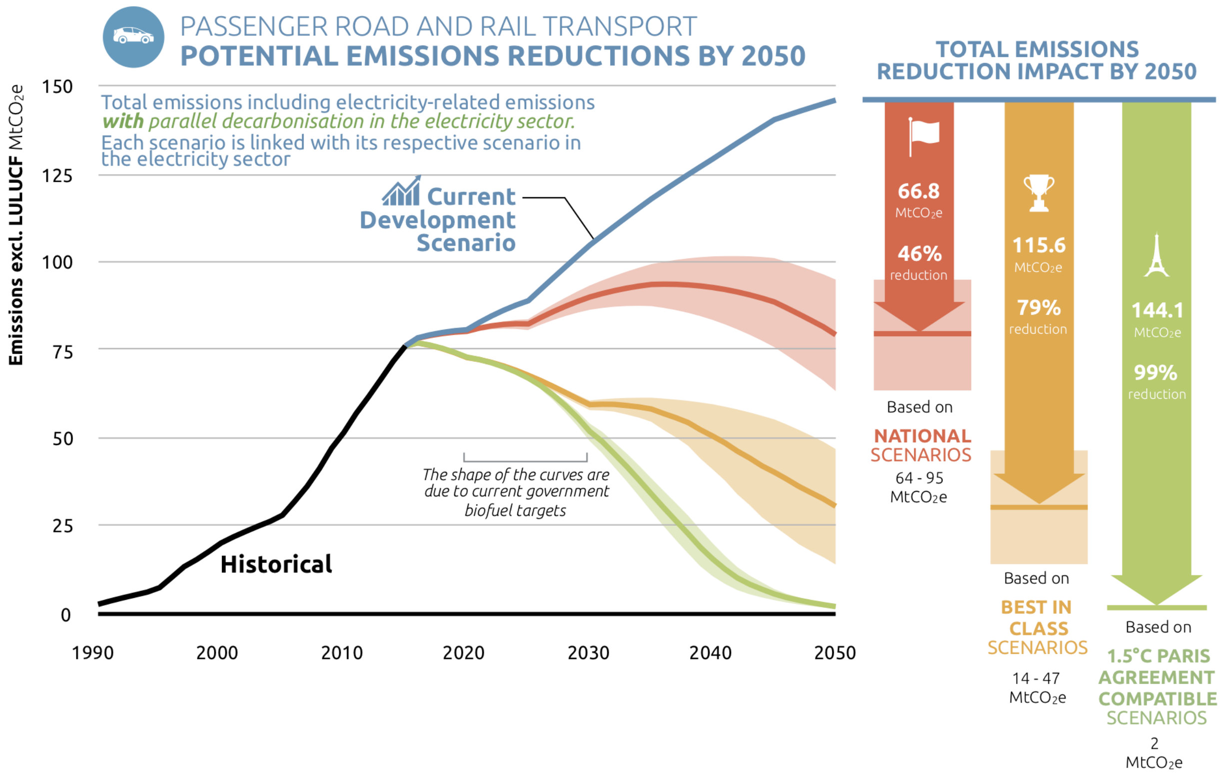


Figure 2: Overview of sectoral emission pathways under current policies and different levels of accelerated climate action in the passenger transport sector. All historical data and sectoral projections towards 2050 are from the CAT PROSPECTS Indonesia scenario evaluation tool. Values includes electricity related emissions.

Forestry

Indonesia is one of the world's largest emitters of Land Use, Land Use Change and Forestry (LULUCF) emissions, mainly as a result of deforestation for agricultural expansion on carbon-rich soils. Devastating peat fires also add to these emissions. Therefore, the sector probably has the largest potential for reducing domestic emissions, although interventions in all other sectors are urgent, to prevent fossil-fuel lock-ins, especially given that the rest of the economy is expected to see higher emissions over the coming decades than projected for the forestry sector.

To meet the future demand for palm oil, the Government of Indonesia has set a target to double the production of palm oil by 2020 (compared to 2012), to 40 million tonnes of crude palm oil, and this is expected to increase to eight times this level in 2050 under business-as-usual.

In 2018, President Widodo introduced a moratorium on new oil palm development across the country. Depending on the extent to which forest governance and existing regulations can be successfully executed and sustained, emissions from the forestry sector could therefore either be significantly underestimated or overestimated compared to the baseline considered in this study.

Other key levers to reduce emissions in this sector include stopping peat fires, rapidly reducing deforestation rates and restoring degraded peatlands, which can also reduce their susceptibility to the devastating peat fires that Indonesia has experienced in recent years.

Our Paris Agreement-compatible scenario for the Indonesian forestry sector is based on the 1.5°C pathway from the GLOBIOM model. Under this scenario, emissions from the forestry sector would decrease to zero by 2027 and turn into a net sink of CO_2 emissions before 2030. In the short term, scenarios developed by the Indonesian government follow even more ambitious pathways. If those scenarios were extended beyond 2020 and effectively implemented, Indonesia's forestry and peatland related emissions would be Paris-compatible.

Even in the longer term, the best-in-class scenario achieves equal or lower emissions than the Paris Agreement-compatible scenario, which provides strong evidence for feasibility of the Paris-compatible scenario.

To achieve the emission cuts in the Paris Agreement-compatible scenario, it is crucial that the moratorium on peatland deforestation remains and is strictly enforced. Deforestation should be reduced to almost zero by 2040, in combination with strong afforestation and reforestation programmes to still enable net deforestation emissions to be zero by 2030.

The remarkable achievements the Peatland Restoration Agency made in 2017—which saw a 60% reduction in deforestation and significant progress made on peatland restoration—should continue until emissions from deforested peatland are fully mitigated before 2030. Indonesia should extend the existing moratorium on new licenses for palm oil and mining concessions which, together with effective land swapping schemes, are seeing peatlands being excluded from future expansion of palm oil plantations. The momentum that increased significantly since the large 2015 peat fires in Indonesia should be used to halt emissions from peat fires by 2020, which would limit severe damages to the economy, public health and the environment.

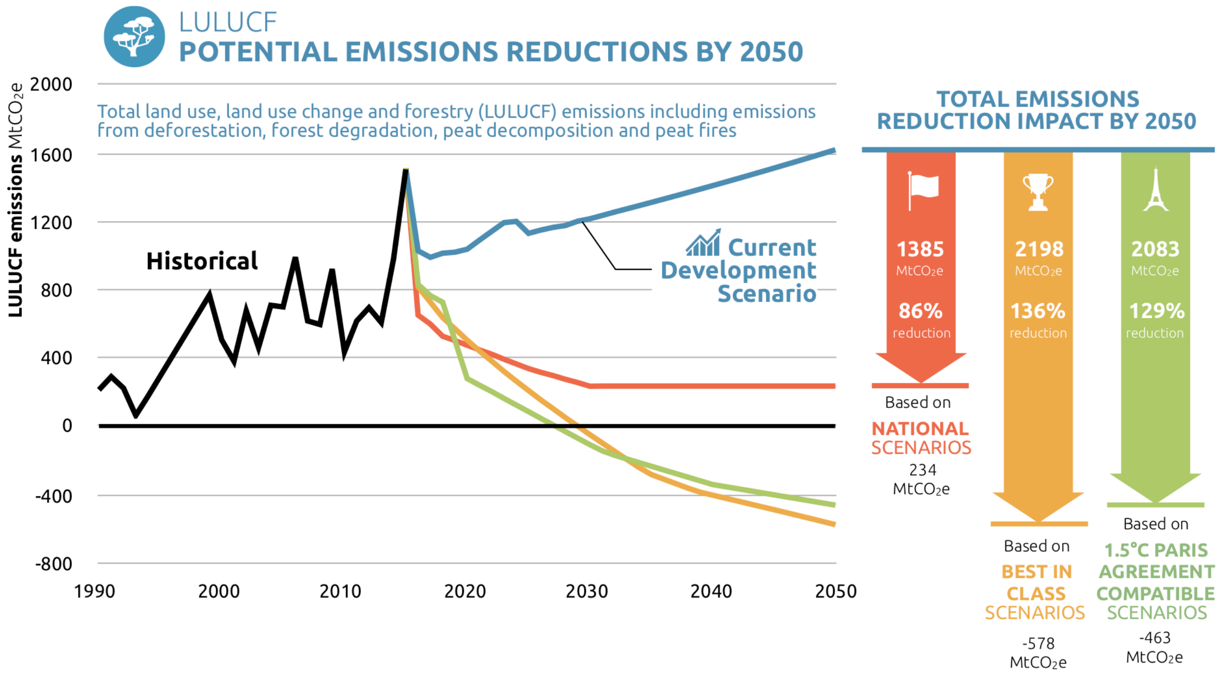


Figure 3: Overview of sectoral emission pathways under current development and different levels of accelerated climate action in the forestry sector, including emissions from deforestation, forest degradation, peat decomposition and peat fires. Historical data are from Indonesia's 1st Biannual Update Report (2015), and emission projections towards 2050 were done in a separate CAT forestry scenario evaluation tool

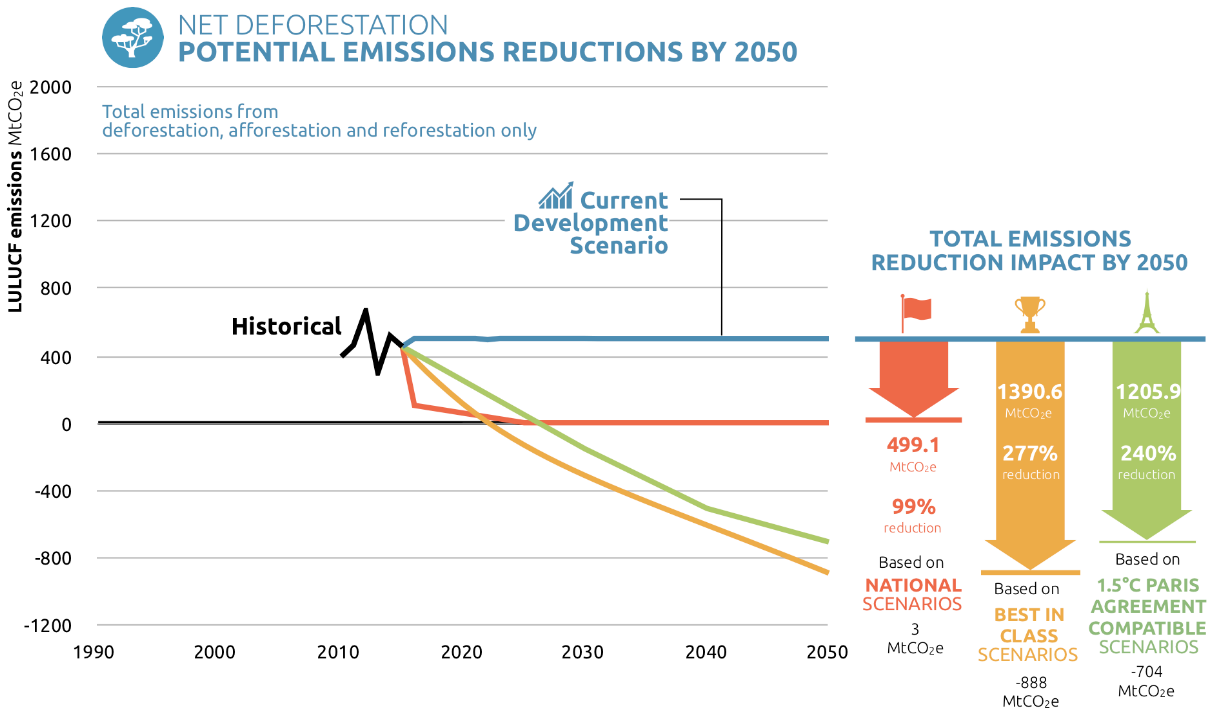


Figure 4: Overview of emission from deforestation, afforestation and reforestation only under current development and different levels of accelerated climate action Historical data are from Indonesia's 1st Biannual Update Report (2015), and emission projections towards 2050 were done in a separate CAT forestry scenario evaluation tool. Note that emissions in the upper graph are harmonized with emissions from Indonesia's GHG inventory, and that therefore emissions from deforestation are higher in this dataset compared to the data showed in the upper graph.

Accelerated climate action and Indonesia's emission reduction target

Under current developments, and without further action, Indonesia's GHG emissions are projected to double by 2030, mainly driven by population growth and addressing growing energy demand with increased use of carbon-intensive fuels. As highlighted above, Indonesia already has policies to support climate action in some sectors, but aligning with the Paris Agreement's 1.5°C limit will require more action in all sectors.

Scaling up climate action in the three key areas, electricity supply, passenger transport, and forestry (which cover about 70% of Indonesia's current emissions), could initiate the required transition and peak Indonesian greenhouse gas emissions shortly after 2030 (excl. LULUCF).

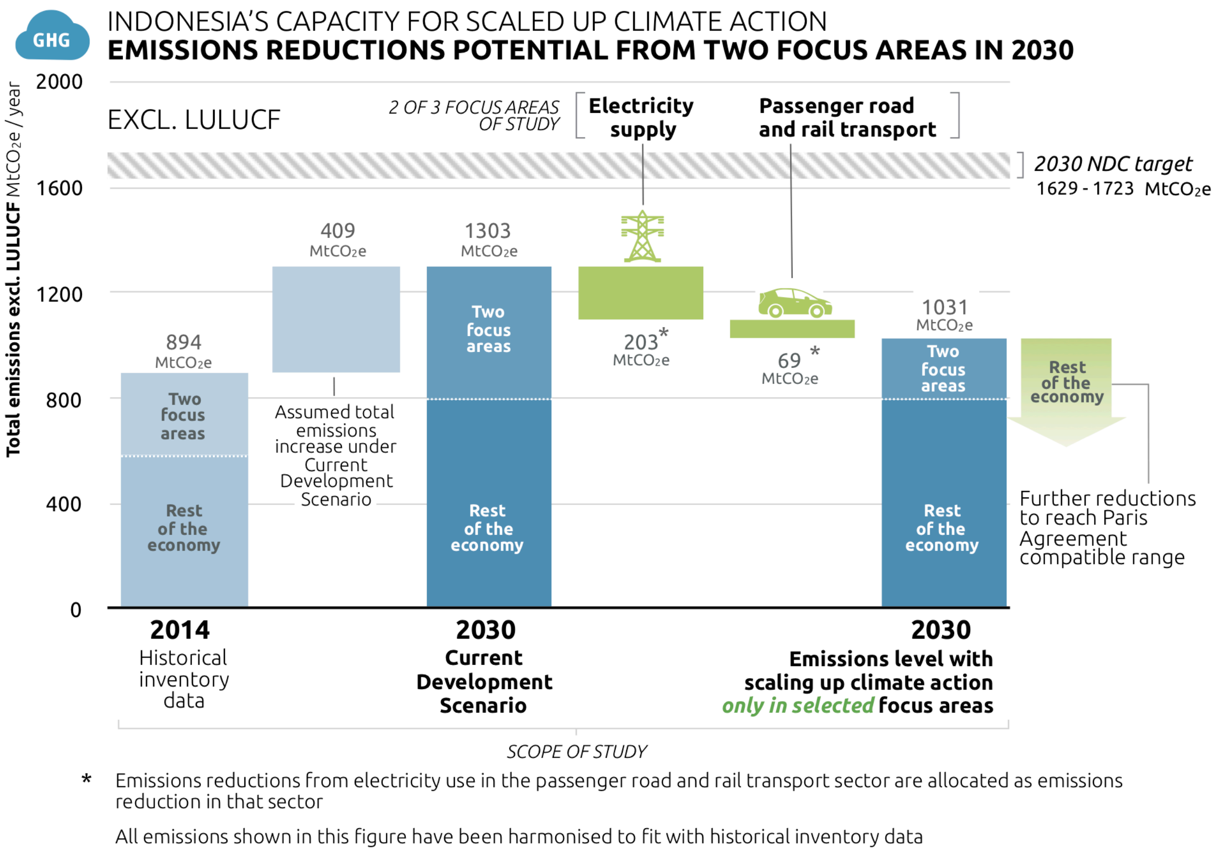
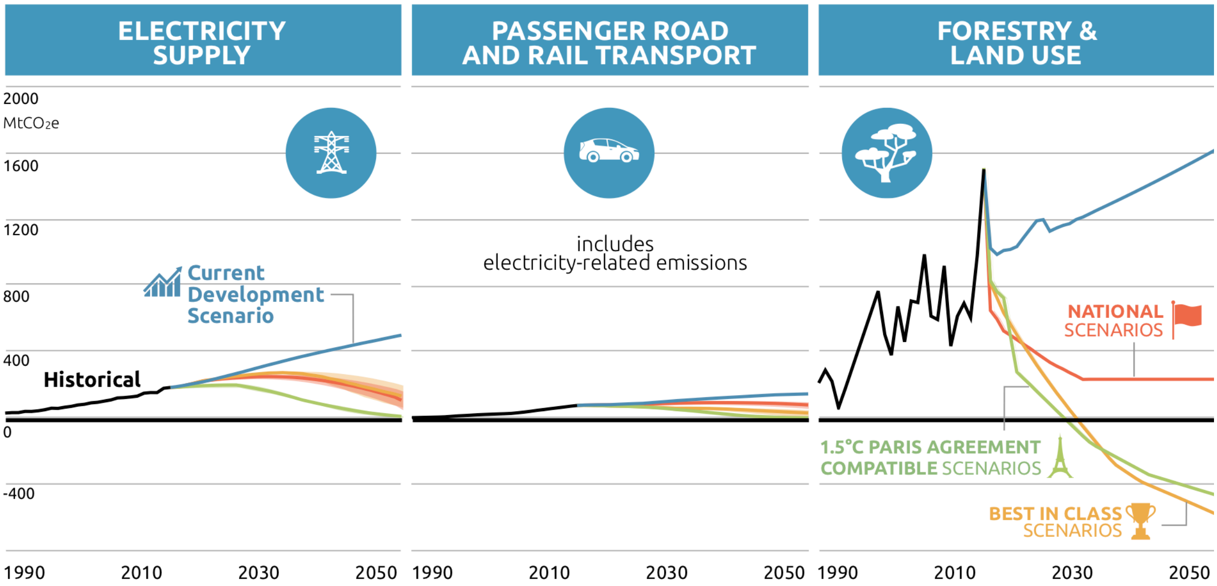


Figure 5: Overview of emissions levels excluding LULUCF under different scenarios for two focus areas. All electricity-related emissions reductions from the transport sectors are allocated as emissions reductions in the end-use sector.

Taking into account LULUCF emissions, Indonesia could achieve a reduction of up to 20% below 2010 levels through actions in these focus areas alone by 2030. Such reduction would significantly overachieve currently projected 58-68% emissions increase in 2030 under Indonesia's conditional and unconditional Paris Agreement NDC targets.

Figure 6 summarises the various scenarios assessed in the study and highlights the key policy recommendations that would support the required level of climate action in the three sectors of focus.

SCALING UP CLIMATE ACTION IN INDONESIA
POTENTIAL EMISSIONS REDUCTIONS IN THREE FOCUS AREAS BY 2050



Electricity supply

- **Improve renewable energy investment climate** by revising the feed-in-tariff scheme, removing administrative barriers, removing fossil fuel subsidies, improving logistical infrastructure and rolling back new risk sharing principles in power-purchasing agreements with PLN.
- **Stop plans for new coal-fired power plants** and instead scale up investment into renewables with large untapped potentials such as solar PV, and related grid and storage infrastructure.

Passenger road and rail transport

- Define ambitious **emissions standards** for new vehicles and enforce the biofuel blending policy, ensuring sustainability safeguards are in place.
- Initiate an ambitious modal shift towards **public mass transport**, especially in urban areas.
- Confirm in legislation the plan to ban fossil-fuel car sales in 2040 latest, better even in 2035.
- Discourage use of private vehicles (e.g. by limiting access in cities), while simultaneously **promoting electric vehicles** with purchase support and "in-kind" benefits.
- **Invest in charging infrastructure** and promote equipment of new (public) buildings with electric charging points.

Forestry & land use

- **Provide more support to sub-national governments** to reduce deforestation, combat peatland decomposition and stop peat fires.
- **Revise land-swapping** schemes for peatland land owners meet the needs of more stakeholders.
- **Extend moratorium** on peatland deforestation.
- **Stimulate communities** to engage in canal blockings to ensure peat does not catch fire.
- **Sustain the successes** achieved under the Peatland Restoration Agency.

Figure 6: Overview of actions to manage the transition to a Paris-compatible pathway in Indonesia's three key sectors.

The status of sectoral transitions: opportunities for accelerating climate action

The transitions towards zero-emissions in the Indonesia electricity supply, urban passenger transport, and forestry sectors have all shown slow progress or have barely begun. Given the status of the policy activities in the three focus sectors, more accelerated and stringent climate action is required to initiate meaningful sectoral transitions. Given the existing significant political barriers to be dealt with, this represents a real challenge for the country.

Table 1 is an overview of this study's evaluation of the current state of policy activity for the three sectors compared with sector-specific benchmarks. These benchmarks represent the most important short-term steps for limiting global warming to 1.5°C identified by the Climate Action Tracker (Kuramochi et al., 2018). The full results of this analysis for all sectors are detailed in Chapter 2 of the report.

Table 1: Summary table for sectoral policy activity and gap analysis in Indonesia for electricity supply, passenger transport and forestry sector. 1.5°C consistent benchmarks relate to most important short-term steps for limiting global warming to 1.5°C identified by the Climate Action Tracker ***(Kuramochi et al., 2018)****. Percentages in the first column indicate the share of national GHG emissions in 2012, calculated based on the Biannual Update Report of 2015.*

Sector	1.5 °C-consistent benchmark	Overall evaluation based on policy activity and gap analysis	Policy rating
Electricity supply sector (12% of GHG emissions)	*Sustain the global average growth of renewables and other zero and low-carbon power until 2025 to reach 100% by 2050*	• Renewable power generation in Indonesia is expected to increase four-fold by 2025 compared to 2016. Given electricity demand will double over this same period, renewables will account for less than a quarter of the power mix in 2025 (up from 11% 2015). This is not in line with a transition pathway to 100% low-carbon by 2050. • There is significant untapped potential for renewable electricity generation, especially based on the large solar resources, and in most regions the costs of rooftop PV have dropped below the national average generation cost. • Policy stability for solar PV is critical for realising this potential. Although many regulatory changes have been made in the past years, administrative barriers still prevail.	Getting Started
	No new coal plants, reduce emissions from coal power by at least 30% by 2025	• 27 GW of new coal-fired power capacity is expected to come online in the coming decade. The 2018 revision of the RUPTL sees the share of coal-fired power increase to 58% by 2027 instead of the 52% reported one year earlier[2]. • Indonesian power sector CO_2 emissions are projected to increase from 220 $MtCO_2$ in 2018 to 366 $MtCO_2$ in 2027 (+66%), primarily due to the growth in coal-fired power generation—87% of these emissions are expected to come from coal.	No Action
Passenger transport (8% of GHG emissions)	*Last fossil fuel car (or personal vehicle) sold before 2035*	• A Low Carbon Emission Vehicle (LCEV) programme is under development where hybrid vehicles will be incentivised financially. Indonesia is considering a ban on fossil-fuel car sales from 2040 onwards. • *A strong biofuel mandate supports decarbonising internal combustion engines, though sustainability concerns around deforestation first need to be urgently addressed.* • Two-wheelers are the most popular form of personal transport across Indonesia. A transition to zero-carbon two-wheelers is therefore crucial, and current plans for electrification (less than 3% in 2030) are not sufficient to meet the benchmark. • Indonesia is developing a large long distance highspeed railway system between Jakarta and Bandung and a metro infrastructure in Jakarta, helping to cope with expected increase in overall travel demand.	Getting Started

2 In March 2019, the 2019 RUPTL was published. This was beyond the cut-off date for this report, but the Electricity Supply Business Plan shows similar levels of renewables deployment as that of the year before. Total coal capacity additions are similar as in previous plans, however the 2019 RUPTL frontloads coal capacity additions to the next years.

Forestry (53% of GHG emissions)	*Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by 2025*	• In 2015, Indonesia lost more than 700,000 hectares of forest, (from the very high peat fires in that El Nino year). The net-zero deforestation target is unlikely to be met by 2025 under current conditions. • 2017 saw a 60% reduction in deforestation, in part due to the moratorium on peatland drainage. Significant progress was made on peatland restoration, as a part of the Peatland Restoration Agency's initiative of restoring 2.4 million hectares of peatland by 2025. • There is significant momentum in Indonesia to address peat fires, although sub-national governments require more support for sustainable development. Land-swapping schemes for peatlands under concession require revisions to better meet all stakeholders' needs.	

Co-benefits of upscaled climate action: employment

Accelerated climate action in Indonesia can generate significant socio-economic co-benefits. Various studies have demonstrated the significant positive impacts of a low-carbon economy on local air pollution reduction (through expansion of non-biomass renewables), economic growth (through local development of innovative, zero-carbon technologies such as solar panels and electric vehicles infrastructures) and energy security for isolated islands.

Our assessment indicates that, with the right policies to support the required transition in some sectors, increasing the renewable energy share in the electricity sector would also yield substantial employment benefits for Indonesia. In all the CAT 'Scaling Up Climate Action' scenarios, the total number of direct jobs in the electricity sector from 2020 to 2030 is higher than the estimated total jobs in the current development scenario.

We find that the most ambitious scenario in terms of emissions reductions also yields the highest employment benefits over time, with an average potential of up to more than 290,000 additional direct jobs compared to current developments over the period 2020 to 2030.

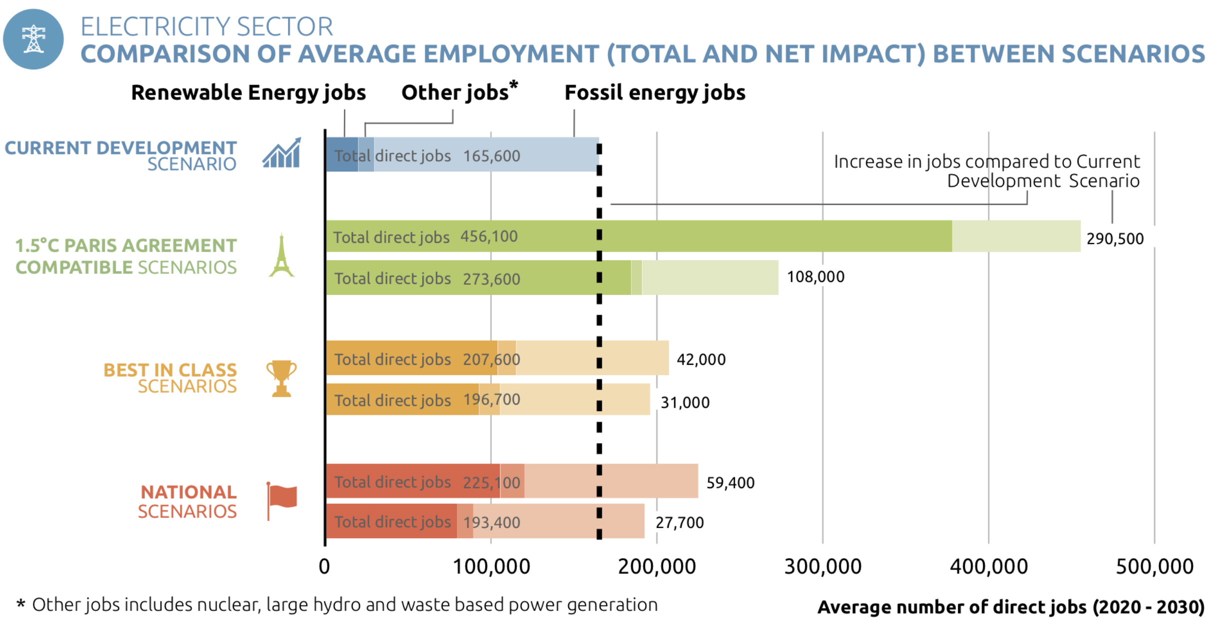


Figure 7: Average direct employment (FTE) impact between 2020 and 2030 in Indonesia per technology for different electricity generation scenarios. Shown is the estimated total direct jobs in the electricity sector averaged over the period 2020 to 2030, in the scenarios analysed in this study. The respective net direct employment impact compared to the reference scenario is also shown for each analysed scenario.

In terms of technologies, solar development is playing a central role in the future low-carbon electricity system of the most ambitious scenario, potentially representing an average of more than 360,000 jobs over the period 2020 to 2030.

By contrast, the scenario assumes that coal capacity will remain capped at its current level until 2025 and will reduce rapidly afterwards. This is key to remaining within the objective set by the Paris Agreement and avoiding high risks of stranded coal assets. While such rapid development could negatively impact local coal mining jobs, we also find the loss will be largely outweighed by additional new jobs in the building and operation of renewables in the long term.

This would give the domestic coal supply sector around five years to adapt and implement a "just transition" towards renewables. The potential impact on coal export-related jobs (e.g. if the rest of the South-East Asia region also moved towards a coal-phase out) has not been included in the analysis.

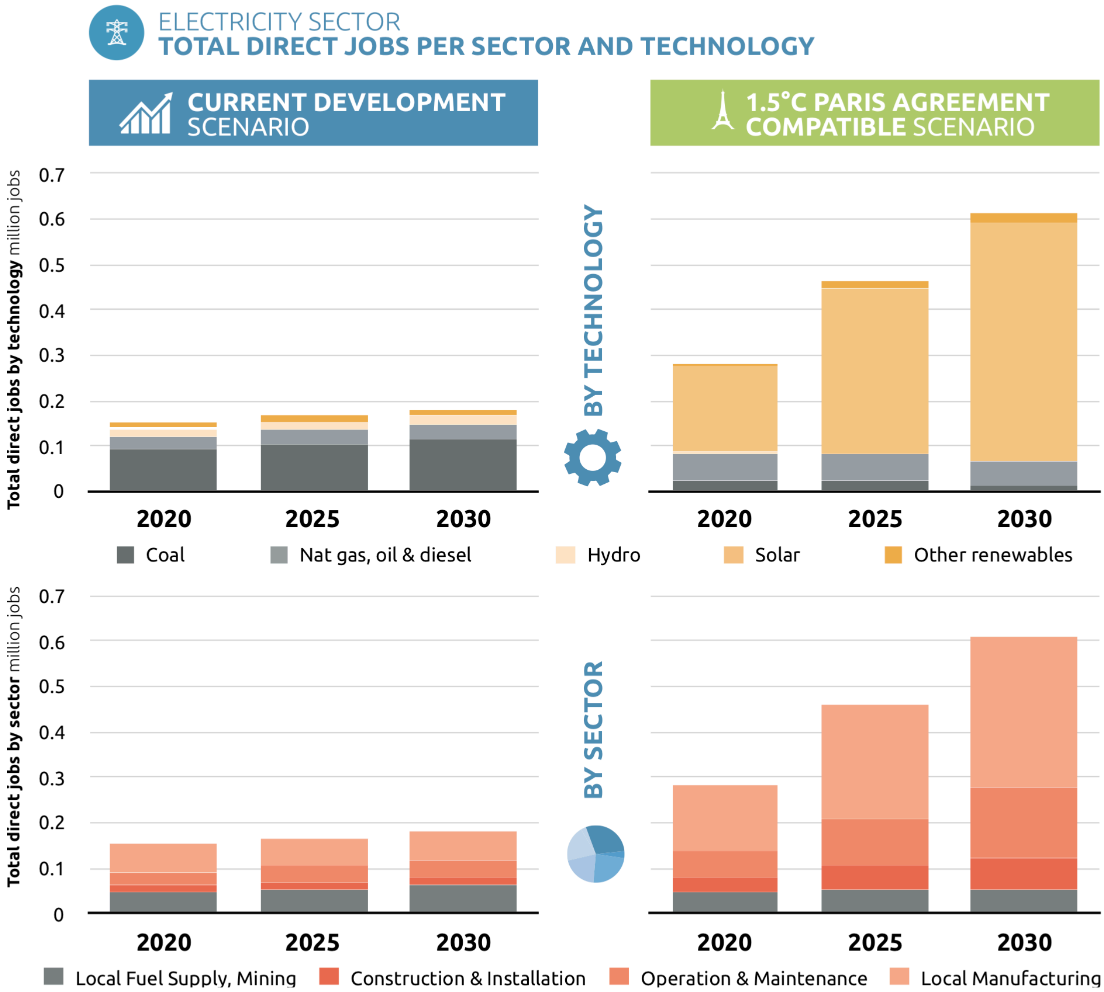


Figure 8: Total direct jobs per generation technology and total direct jobs per employment sector for the Current Development scenario (graphs on left) and the 1.5°C Paris Agreement compatible scenario (graphs on right) for the electricity supply sector. Note: 'other renewables' comprises of wind, biofuels, geothermal, marine and waste.

In the most ambitious scenario, more than half the jobs will be related to the construction and the installation of new power generation, mainly around the large amount of additional renewable capacity to be installed in the decade to come. In this scenario, it is also expected that many additional long-term and high-skilled jobs related to operation and maintenance of renewable plants will be generated.

Our analysis does not include the expected positive impacts on local and high skilled jobs in the development of electricity transport and distribution needs in the most ambitious scenarios.

Abbreviations

B2DS	Beyond 2°C Scenario
BRG	Peatland Restoration Agency
BRT	Bus rapid transit
BUR	Biennial Update Report
CAGR	Compound Annual Growth Rate
CAPEX	Capital expenditure
CDS	Current development scenario
CPO	Crude Palm Oil
GHG	Greenhouse Gases
ICE	Internal Combustion Engine
IPP	Independent Power Producer
ISPO	Indonesian Sustainable Palm Oil (certification scheme)
KRL	Commuter Rail
LCEV	Low Carbon Emission Vehicle
LULUCF	Land-Use, Land-use Change and Forestry
NEP	National Energy Plan
NDC	Nationally Determined Contribution
OPEX	Operational expenditure
PA	Paris Agreement
PLN	Perusahaan Listrik Negara (Indonesia's state-owned transmission system operator)
Solar PV	Solar Photovoltaic
RAN-GRK	National Action Plan for Greenhouse Gas Emission Reduction
RPJMN	National Medium-Term Development Plan
RUPTL	Electricity Supply Business Plan
RUEN	National General Energy Plan
TPES	Total Primary Energy Supply

Contents

Introduction

Background and objectives

Under the Paris Agreement, governments have committed to limiting temperature increase to well below 2°C above pre-industrial levels and pursuing efforts to limit it to 1.5°C. Current efforts are insufficient: aggregate mitigation targets, according to Climate Action Tracker (CAT) estimates, result in global warming of about 3.2°C (Climate Action Tracker, 2017b). Implementation of the targets is falling short, with greenhouse gas (GHG) emissions under implemented policies leading to an estimated warming of around 3.4°C.

To stay below the globally agreed limit, the IPCC Special Report on 1.5℃ finds that an increase in efforts is required to peak global GHG emissions as soon as possible, reduce CO_2 emissions to net-zero around 2050 and total GHG emissions shortly thereafter (IPCC, 2018).

In recent years, measures to reduce GHG emissions have, in many cases, become more attractive to policy makers and private investors, both because of falling technology costs, as well as increased awareness for other benefits, such as air quality improvements and employment benefits in low-carbon-oriented sectors.

We no longer live in a world where climate change mitigation is a burden per se, but where it increasingly becomes the most feasible option when considering all socio-economic aspects. For cost-efficient global mitigation, it will be essential to make those mitigation actions accessible to and overcome remaining barriers in all countries.

This report, the first country assessment in the Climate Action Tracker's Scaling Up Climate Action Series, analyses areas where Indonesia could accelerate its climate action. The report illustrates GHG emissions reductions from such actions, along with other benefits.

Approach

The analysis starts with an in-depth review of Indonesia's current policy framework and sectoral developments, comparing them with the comprehensive policy packages and the progress of the kind of sector indicators required under Paris-compatible pathways.

The report then focuses on three areas we have identified with promising potential to increase mitigation efforts, also considering national and even local circumstances: electricity supply, urban passenger transport, and residential buildings.

For these areas, we research different pathways which go beyond current efforts, explain the feasibility of such increased action, and quantify resulting emission reductions and employment benefits. We consider three types of scenarios: (1) Outputs from national research institutions analysing alternative scenarios to current government projections, (2) Paris-compatible benchmarks from international sources such as the IPCC Special Report on 1.5°C (IPCC, 2018) or the CAT's report on short-term steps (Kuramochi et al., 2018), and (3) Best-in-class levels from regional or global frontrunners (compare (Fekete et al., 2015; Roelfsema et al., 2018).

The external scenarios provide trajectories of sectoral indicators, for example for the share of renewable energy. For the quantification of sectoral and total emission trajectories until 2050, the Scaling Up Climate Action series uses the CAT's PROSPECTS scenario evaluation tool. To estimate domestic employment impacts of different electricity supply sector development, we use a spreadsheet-based economic model developed by NewClimate Institute under the "Ambition to Action" project, the Economic Impact Model for Electricity Supply (EIM-ES).

A methodological annex presenting the tools' methodologies and key assumptions for data filling can be accessed under climateactiontracker.org/publications/scalingup/methodology.

1 Context for scaling up climate action in Indonesia

While Indonesia is very vulnerable to climate change, with the IPCC identifying the South East Asia region as one of the hotspots, the translation into actionable policies to effectively combat climate change in Indonesia remains inadequate. The IPCC's Special Report on 1.5°C finds that climate change has multiple adverse effects for Indonesia, including an increase in surface run-off, extreme low- and high-flows, severe droughts and at least 50 million people exposed to the effects of sea level rise (Clark et al., 2016; Döll et al., 2018).

The IPCC Special Report on 1.5°C has found that limiting warming to 1.5°C will reduce the impacts on vulnerable populations and ecosystems in Indonesia, compared to 2°C warming (IPCC, 2018). Furthermore, the report finds that the low-carbon transition required to limit warming to this level will have significant benefits for access to clean and affordable energy, and poverty eradication—both Sustainable Development Goals.

Indonesia specifies a target under the Paris Agreement of reducing by 29% below business-as-usual GHG emissions by 2030, which they will likely achieve. However, the Climate Action Tracker rates the non LULUCF target "Highly insufficient", since emissions would still double under a current policies trajectory by 2030. Indonesia also aims to meet a large share of around 60% of its commitments through emissions reductions in the forestry sector. This means that other sectors will see substantially lower relative reductions of emissions below business-as-usual.

Indonesia is drawing global attention because of significant increase in emissions from its forestry sector. The country is working since 2005 on improving its forest and peatland governance and management by creating task forces and establishing clear mitigation plans but the authorities are still facing challenges to implement them. Emissions are still projected to increase in the next years (Wijaya, Chrysolite, Ge, Wibowo, & Pradana, 2017), even if existing measures are full. Halting LULUCF emissions is paramount in the global context, considering the contribution of this sector to the NDC targets and the fact that Indonesia is the biggest LULUCF emitter in the world. Massive peat fires in 2015 and 2018 have given renewed momentum to addressing the issue of deforestation on peatland and restoring and rewetting drained peatlands.

The Government of Indonesia is at the same time increasingly turning towards coal to meet the country's rapidly rising energy demand and deliver energy independence to all remote islands. While coal investments are decreasing in most countries, this is not the case in Indonesia, where planned addition to capacity in coal fired power is larger than plans for renewable energy. Exporting around 80% of its coal production of 460 million tonnes in 2017 (PwC, 2018), Indonesia is the largest exporter of coal in the world after Australia (IEA, 2019). Rising coal prices have boosted domestic coal production and spread uncertainty over the government's plan to limit coal production to 400 million tonnes by 2019. Another influencing factor is the significant new funding opportunities towards fossil fuel infrastructure that is being channelled to Indonesia by major Asian economies such as Japan, South Korea and China. This, combined with domestic interests, has led Indonesian politics to be entangled with the coal industry (Greenpeace, JATAM, ICW, & Auriga, 2019). This dependence on coal impedes

Indonesia's transition towards a renewable energy system and the utilisation of their vast renewable energy potential. Possessing the second largest geothermal resource in the world, Indonesia has a theoretical potential of 29 GW. In addition, solar PV is currently negligible in Indonesia but has a potential of 200–1,000 GW, and offshore wind could provide up to 1,000 GW in the medium to long-term (Deng et al., 2015b; EBTKE, 2016; IRENA, 2017a). The potential from other renewable sources is less important but could provide additional local opportunities, with up to 60GW potential from onshore wind (Dewan Energi Nasional, 2016) and around 18 GW for ocean energy. Combined, these resources could cover current electricity demand in Indonesia several times over.

Indonesia's key overarching energy legislation is embedded in the National Energy Policy (NEP), which has a target to increase renewable energy to 23% of total primary energy supply (TPES) by 2025 from 4% in 2017. **On the other hand, due to significant projected growth in energy demand, around 27 GW of coal capacity is still expected to be added in the power sector, compared to the 15 GW[3] based on renewable sources** (Ministry of Energy and Minerals of the Republic of Indonesia, 2018)**.** Under these developments, the target in the NEP will not be met, and the country would be bound to a carbon-intensive power sector for decades. Indonesia is considering the implementation of at least one market-based instrument before 2024 to help achieving its commitments. It has issued a governmental regulation that mandates an emissions and waste permit trading system and is still to decide among four market-based options, including carbon offsetting and an emissions trading system, that would affect the power and industry sectors by putting a price on the emitted CO_2 (Reklev, 2018). Indonesia received international praise previously for a well-managed reduction in fossil fuel subsidies in transport, but these efforts need to be significantly scaled up to spur decarbonisation (Savacic, 2016).

Table 2 provides an overview of all overarching climate change policies in Indonesia.

3 4.5 GW geothermal power, 8 GW hydro power and 2 GW other renewables (includes solar PV and bioenergy).

Table 2: Overview of implemented overarching climate change policies in Indonesia

<table>
<tr><th colspan="5">OVERARCHING CLIMATE CHANGE POLICIES OF INDONESIA</th></tr>
<tr><th>Changing activity</th><th>Energy efficiency</th><th>Renewables</th><th>Nuclear or CCS or fuel switch</th><th>Non-energy</th></tr>
<tr><td colspan="5">Climate Strategy
▪ National Long-Term Development Plan (RPJPN) 2005–2025 (2004)
▪ National Action Plan Addressing Climate Change (2007)
▪ National Action Plan to reduce GHG emissions (RAN-GRK) (2011)
▪ National Medium-Term Development Plan (RPJMN) 2015-2019 (2014)</td></tr>
<tr><td colspan="5">GHG reduction target
▪ National Action Plan to reduce GHG emissions (RAN-GRK) (2011)
▪ National Medium-Term Development Plan (RPJMN) 2015-2019 (2014)
▪ Intended Nationally Determined Contribution (INDC) (2015)</td></tr>
<tr><td colspan="5">Coordinating body for climate change
▪ Directorate General of Climate Change. Former: National Council on Climate Change (DNPI)</td></tr>
<tr><td colspan="5">Support for low-emission R&D
▪ Regulation on Energy and Water Efficiency (2008)</td></tr>
<tr><td></td><td>National energy efficiency target
▪ Presidential regulation 70/2009 concerning Energy Conservation (2009)</td><td>National renewable energy target
Law 30/2007 Regarding Energy (2007)</td><td></td><td></td></tr>
</table>

(lightest shading)	*No policies currently exist and a similar policy gap exists in all other countries*
(grey shading)	*No policies currently exist however Indonesia could adopt policies from other countries*
(blue shading)	*Existing and planned policies for Indonesia*

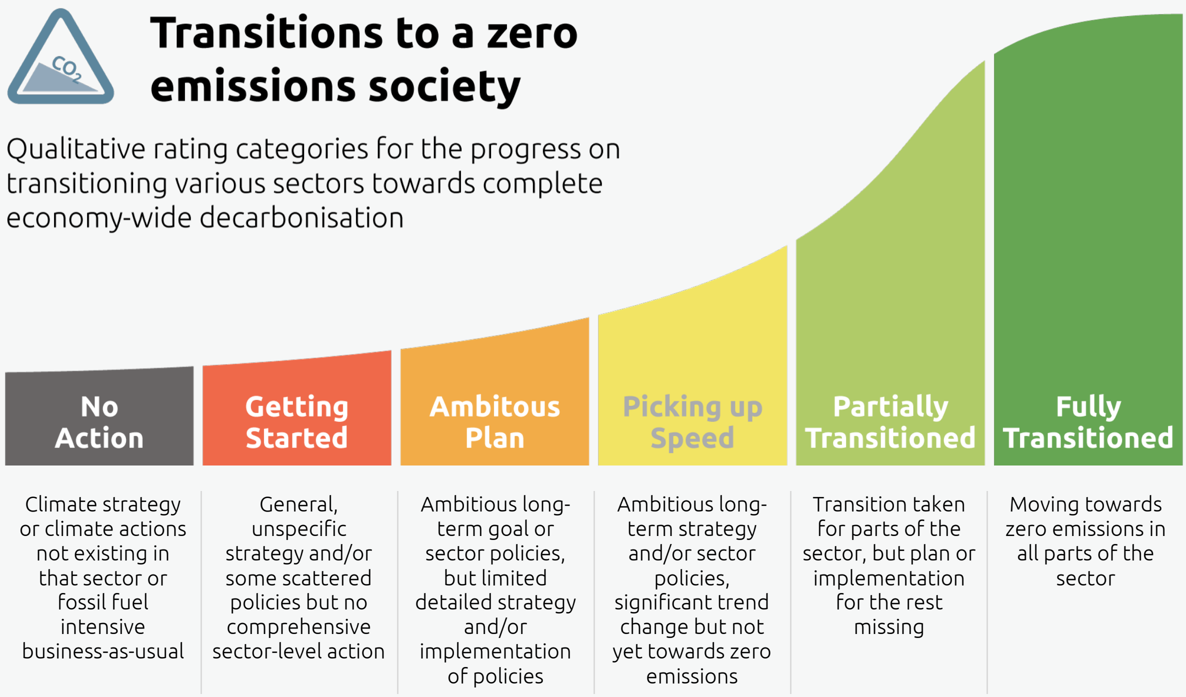
2 Overview of national climate policy actions and gaps

This chapter provides a comprehensive overview of existing and planned climate policies at the national level in Indonesia. This chapter is divided into five subsections, each representing an Indonesian economic sector. The first part of each subsection overviews all existing climate change mitigation policies in that sector and their implementation status. The second part identifies gaps of existing policies compared to required policy action for a Paris Agreement compatible "emissions" pathway. The policy ambition analysis assesses how Indonesia's implemented policies compare to the most important short-term steps for limiting global warming to 1.5°C (Kuramochi et al., 2018). We compare policy progress to actionable benchmarks in each sector and rate it according to a qualitative policy rating (see Box 1 below).

The policy ambition analysis compares historical and projected developments under current policies to the global indicators without any further adjustments of the indicators to country-specific circumstances, such as for example the respective capabilities of countries. The policy ambition analysis mainly provides an indication to which degree current trends in each sector align with required steps on a global level and presents a standardised approach for all countries analysed in the CAT Scaling Up Climate Action series. The in-depth analysis in Chapter 4 addresses country specific circumstances and considerations for Indonesia and specific sectors.

Box 1 Qualitative policy rating for sectoral transition to zero-emissions society

The qualitative analysis of policy activity and ambition of this analysis for Indonesia results in a rating of each sector. The rating aims to reflect the sector's current transition state towards 1.5°C Paris Agreement compatibility. For this purpose, the rating accounts for existing sectoral long-term strategies and/or policies, their status of implementation, as well as the general state of transition of the sector under analysis.



Key findings of policy activity and policy ambition analysis

Table 4 summarises the key findings of the policy activity and gap analysis for each of the sectors and the respective sectoral benchmarks. The qualitative rating evaluates the current sectoral status in transitioning to 1.5°C Paris Agreement compatibility.

Table 3: Summary table for sectoral policy activity and gap analysis in Indonesia.

Sector	1.5 °C-consistent benchmark	Overall evaluation based on policy activity and gap analysis	Policy rating
Electricity and heat sector	Sustain the global average growth of renewables and other zero and low-carbon power until 2025 to reach 100% by 2050	• Renewable power generation in Indonesia is expected to increase four-fold by 2025 compared to 2016. Given electricity demand will double over this same period, renewables will account for less than a quarter of the power mix in 2025 (up from 11% 2015). This is not in line with a transition pathway to 100% low-carbon by 2050. • There is significant untapped potential for renewable electricity generation, especially based on the large solar resources, and in most regions the costs of rooftop PV have dropped below the national average generation cost. • Policy stability for solar PV is critical for realising this potential. Although many regulatory changes have been made in the past years, administrative barriers still prevail.	Getting Started
	No new coal plants, reduce emissions from coal power by at least 30% by 2025	• 27 GW of new coal-fired power capacity is expected to come online in the coming decade. The 2018 revision of the RUPTL sees the share of coal-fired power increase to 58% by 2027 instead of the 52% reported one year earlier[4]. • Indonesian power sector CO_2 emissions are projected to increase from 220 $MtCO_2$ in 2018 to 366 $MtCO_2$ in 2027 (+66%), primarily due to the growth in coal-fired power generation—87% of these emissions are expected to come from coal.	No Action
Transport sector	Last fossil fuel car sold before 2035	• A Low Carbon Emission Vehicle (LCEV) programme is under development where hybrid vehicles will be incentivised financially. Indonesia is considering a ban on fossil-fuel car sales from 2040 onwards. • A strong biofuel mandate supports decarbonising internal combustion engines, though sustainability concerns around deforestation first need to be urgently addressed. • Two-wheelers are the most popular form of personal transport across Indonesia. A transition to zero-carbon two-wheelers is therefore crucial, and current plans for electrification (less than 3% in 2030) are not sufficient to meet the benchmark. • Indonesia is developing a large long distance highspeed railway system between Jakarta and Bandung and a metro infrastructure in Jakarta, helping to cope with expected increase in overall travel demand.	Getting Started

4 In March 2019, the 2019 RUPTL was published. This was beyond the cut-off date for this report, but the Electricity Supply Business Plan shows similar levels of renewables deployment as that of the year before. Total coal capacity additions are similar as in previous plans, however the 2019 RUPTL frontloads coal capacity additions to the next years.

Sector	Benchmark	Assessment	Status
	Aviation and shipping: Develop and agree on a 1.5°C compatible vision	• Current policy scope is limited to short term and does not provide enough detail to qualify for a comprehensive 1.5°C compatible vision for the transport sector in Indonesia. • There are no strategies or policies on greener or sustainable maritime shipping in Indonesia	Getting Started
Buildings sector	All new buildings fossil free and near zero energy by 2020	• Although buildings emissions intensity is on the rise, the current level is around 0.5 tCO2/capita (2014). That is half of the global average and represents the intensity level that is required in 2020 to be consistent with a 1.5°C-pathway. • Indonesia is introducing green building standards (for commercial and public buildings) in its major cities and is therefore making good progress towards having its cnew buildings fossil free and near-zero energy by 2020. • Residential sector is the most important sub-sector in terms of energy use, and is lacking ambitious standards.	Getting Started
	Increase building renovation rates from <1% to 5% by 2020	• There is some development in policies for building renovation in Indonesia, but due to the rapidly increasing welfare levels and a high new build rate, renovation of existing buildings is underemphasised in Indonesia. • This also means that Indonesia will most likely not meet the benchmark of increasing building renovation rates from <1 to 5% by 2020	No Action
Industry sector	All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency	• Indonesia's cement and steel sectors have shown initiative to enhance material efficiency and decarbonise their production processes. • Some specific policies have been formulated for the cement sector and some goals have been specified for some sub-sectors but the benchmark is not yet within reach in Indonesia, even for the steel and cement sectors	Getting Started
LULUCF	Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by 2025	• In 2015, Indonesia lost more than 700,000 hectares of forest, (from the very high peat fires in that El Nino year). The net-zero deforestation target is unlikely to be met by 2025 under current conditions. • 2017 saw a 60% reduction in deforestation, in part due to the moratorium on peatland drainage. Significant progress was made on peatland restoration, as a part of the Peatland Restoration Agency's initiative of restoring 2.4 million hectares of peatland by 2025. • There is significant momentum in Indonesia to address peat fires, although sub-national governments require more support for sustainable development. Land-swapping schemes for peatlands under concession require revisions to better meet all stakeholders' needs.	Ambitious Plan
Commercial Agriculture	Keep emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research	• Indonesia's agriculture programmes have led to significant improvements in livestock efficiency. • Focus on land-based agriculture should increasingly shift towards increases in land productivity instead of opening new lands.	Ambitious Plan

2.1 Electricity and heat sector

The Indonesian electricity supply sector is the largest producer of power and consumer of energy in Southeast Asia (Cornot-Gandolphe, 2017). Simultaneously, the sector is also the largest source of emissions after the LULUCF sector, responsible for around 25% of total emissions (excl. LULUCF; 12% incl. LULUCF) (Government of Indonesia, 2017). Since heat generation is not so relevant in the Indonesian context, the predominant focus of this chapter will be the electricity supply sector.

Table 4: Indonesia's progress on the most important indicators in the power sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Electricity and heat sector	*Sustain the global average growth of renewables and other zero and low carbon power until 2025 to reach 100% by 2050*	• Generation of renewable power will increase four-fold by 2027 in Indonesia, compared to 2018. • Due to a rapidly rising electricity demand and policies aimed at reducing imports of petroleum, Indonesia appeals mostly to coal resources to meet increasing demand. • Renewables will under current plans make up 20% of the fuel mix by 2027 thus not achieving its target of 25% by 2025.	• The sector is not in line with a transition pathway to 100% low-carbon by 2050 and projected share of renewables remains limited. • Significant untapped potential exists for renewable electricity generation and in most regions the costs of rooftop PV have dropped below the national average generation cost. • *Policy stability is critical for realising renewable potential. Although many regulatory changes have been made in the past years, administrative and regulation barriers (including subsidising coal vs. renewable energy) still prevail.*	Getting Started
	No new coal plants, reduce emissions from coal power by at least 30% by 2025	• 27 GW of new coal-fired power capacity is expected to come online before 2027. A recent revision of the RUPTL in 2018 sees a shift back to coal from previous plans for a steeper increase in renewables. • Indonesian power sector CO_2 emissions are projected to increase from 220 $MtCO_2$ in 2018 to 366 $MtCO_2$ in 2027 (+66%), implying no appreciable reduction in power emissions intensity.	• Due to a rapidly rising electricity Significant coal capacity is expected to be added. There are currently no signs that the government is planning to phase out coal capacity or at least reduce the currently planned pipeline.	No Action

Indonesia has been and is still facing rapid increases in electricity demand. Perusahaan Listrik Negara (PLN), Indonesia's state-owned transmission system operator, projects an electricity demand growth of more than 83% between 2018 and 2027, reaching a total of 502 TWh from 274 TWh in 2018 (Ministry of Energy and Minerals of the Republic of Indonesia, 2018). This is an increase of 6.9% per year. The country's power grids are in a critical condition and in 2017 only half of the power systems in the country had sufficient peak capacity available (PLN, 2017). To meet the rapidly increasing electricity demand and maintain grid stability, 56 GW of power capacity is expected to be added between 2017 and 2027, in addition to around 61 GW of installed capacity in 2017. The capacity grows more than the power demand, indicating a decrease in asset utilization likely due to the increase of renewables in the power fuel mix.

According to the government's plans, Indonesian power sector's CO_2 emissions are projected to increase from 220 $MtCO_2$ in 2018 to 366 $MtCO_2$ in 2027 (+66%), primarily due to the growth in coal-fired power generation, since 87% of these emissions are expected to come from coal. In 2017, Indonesia generated 57% of its electricity from coal-fired power, 25% from gas, 6% from oil and 12% from renewables. Renewables generation has been steadily increasing in absolute terms since 1990, with an average growth rate of 5% per year. However, since electricity demand has been growing at a rate of around 8% per year, the share of renewables in power generation in Indonesia has dropped from 21% in 1990 to 12% in 2016 (IEA, 2018).

One of Indonesia's main objectives is to provide universal access to electricity to all its citizens. Currently, the level of electrification can vary significantly, with western areas seeing rates as high as 99.9% (e.g. Jakarta) and eastern regions as low as 48% (e.g. Papua) (Directorate General of Electricity, 2016). The Indonesian Electricity Supply Plan projects a nation-wide electrification rate of 99.5% by 2027. It should be stressed that this does not necessarily reflect a stable electricity supply for this share of the population.

2.1.1 Actionable benchmarks in electricity and heat sector

The Climate Action Tracker identified two short-term actionable benchmarks for the electricity sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- The growth rates of renewables and other zero and low carbon power ought to be sustained until 2025 to reach a 100% share of electricity generation by 2050.
- No new coal capacity ought to come online as of 2017 and emissions from coal combustion need to be reduced by at least 30% by 2025. A more recent CAT publication supports this direction and suggests reducing the use of coal in electricity by two-thirds between 2020–2030 and phase out coal globally by 2050 (Sterl et al., 2017). This is in line with the IPCC Special Report on 1.5°C (IPCC, 2018). A recent study shows that coal needs to be phased out by 2040 in South East Asia (Climate Analytics, 2019).

The following gap analysis compares historical and projected developments in the Indonesian electricity and heat sector to these global benchmarks. The analysis does not include any further adjustment to allow for comparison between countries under analysis within the scope of this project. Country specific circumstances will be addressed in the in-depth analysis on raising the level of ambition in climate policy in the following chapters. Please refer to the reference publication for more detailed explanation on each indicator.

2.1.2 Recent policy developments

A comprehensive overview of the currently implemented and planned sectoral climate policies is provided in Table 5.

Indonesia has implemented several climate policies that impact the electricity sector, and most importantly the National Energy Policy (2014). In addition, the Indonesian government recently rolled out the Electricity Supply Business Plan 2018–2029 (RUPTL), which outlines future capacity expansion plans, demand and supply forecasts and fuel requirements. Under this plan, Indonesia would see a significant expansion of its coal-fired power fleet. Another piece legislation is the National Medium-Term Development Plan 2015–2019 (RPJMN) which provides more specific short-term targets on primary energy-related priorities. Other important policies include various support schemes for renewables, an ambitious biofuel blending regulation and some tax incentives for renewable energy.

Table 5: Overview of implemented climate change policies in the electricity sector in Indonesia

OVERVIEW OF EXISTING, PLANNED AND POTENTIAL CLIMATE CHANGE POLICIES FOR THE ELECTRICITY IN INDONESIA				
Changing Activity	**Energy efficiency**	**Renewables**	**Nuclear or CCS or fuel switch**	**Non-energy**
	Support for highly efficient power plants ▪ Ministry of Energy Regulation No. 7 (2010)	**Renewable energy target for electricity sector** ▪ Law No. 30/2007 on Energy (2007) ▪ Ministerial Regulation 15/2010 Re. 10,000 MW Crash Programme (2010) ▪ Biofuel Blending (Ministry Regulation No. 25/2013) (2013) ▪ Regulation No. 79/2014 on National Energy Policy (2014) ▪ National Medium-Term Development Plan (RPJMN) 2015-2019 (2015) ▪ Electricity Supply Business Plan (RUPTL) 2018-2027 (2018) ▪ Presidential Regulation No. 22/2017 on the National General Energy Plan (RUEN) (2017)	**CCS support scheme** (none)	
	Reduction obligation schemes (none)	**Support scheme for renewables** ▪ Medium-Scale Power Generation using Renewable Energy (2006) ▪ Law No. 25/2007 on Investment (2007) ▪ Regulation No.21/PMK.011/2010 on Value-Added Tax and Import Duty Exemption for Renewable Energy Property (2010) ▪ Income tax reduction for energy development projects (2010) ▪ Presidential Decree No. 4 (2010) ▪ Purchase of Electricity from Geothermal Plants (2011) ▪ Electricity Purchase from Small and Medium Scale Renewable Energy and Excess Power (2012) ▪ Power purchase from solar photovoltaic Geothermal Fund (2012) ▪ plants (2013) ▪ Feed-in-Tariffs for Biomass (2013) ▪ Feed-in-Tariffs for Biomass and Municipal Waste (Ministerial Regulation No. 27/2014 and No. 44/2015) (2014) ▪ Law 21/2014 New Geothermal Law (2014) ▪ Ceiling Price for Geothermal (2014) ▪ Geothermal auctions (2016) ▪ Solar Feed-In Tariff (2016) ▪ Regulation on the utilisation of Renewable Energy for the Provision of Power (12/2017)		
		Grid infrastructure development ▪ Government Regulation No. 26 (2006)		
		Sustainability standards for biomass use (none)		
Overarching carbon pricing scheme or emissions limit (none)				
Energy and other taxes (none)				
Fossil fuel subsidies ▪ (none)				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Indonesia could adopt policies from other countries

Existing and planned policies for Indonesia

Below we describe Indonesia's key legislation in the power and heat sector, taken from Table 5 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

2.1.2.1 Renewable energy target for electricity sector

Indonesia's **National Energy Policy** was signed and went into force in October 2014 and replaces the 2006 National Energy Plan (NEP), which was primarily focused on decreasing the use of oil in the total primary energy supply (TPES) and increasing the use of coal and gas. This policy also has implications for the electricity supply sector, since it is steering the Electricity Supply Business Plan (RUPTL). The new NEP aims to transform the TPES in 2025 towards 30% coal, 22% oil, 23% renewables and 25% natural gas. For comparison, today's share of renewables in the TPES is around 6% (IRENA, 2017). This target is translated into a specific target for electricity generation of 25% renewables. Based on the projected electricity demand in Indonesia, the Policy projects 115 GW of required power capacity in 2025, and 430 GW in 2050. In addition, the Policy sets out several principles, including the re-establishment of Indonesia's energy independence by shifting from exports to satisfying the demand domestically and focusing on nation-wide electrification, which is challenging given the many islands and other remote islands in Indonesia (IEA, 2014). The national 2050 target is 31% renewable share in TPES. Such target is significantly lower than the IRENA Remap projection that shows that such potential can be achieved 20 years earlier, namely by 2030 (IRENA, 2017).

The **Electricity Supply Business Plan (RUPTL)**, is PLN's annual plan which outlines future capacity expansion plans, demand and supply forecasts and fuel requirements. It also sets out a 10-year development plan for Indonesia's electricity sector. The plan for the period 2018–2027 aims to achieve an electrification rates for Indonesia of 99.5% by 2027, for which at least 56 GW of new power capacity will be added. The RUPTL allocates these capacities to the country's national electricity distribution company (PLN) and independent power producers (IPPs). In line with the National Energy Policy (NEP), the share of renewables in the national energy mix is required to be 23% in 2025 (PWC, 2016), and the RUPTL converts this into planned power capacities for 2025. However, the NEP still allows Indonesia's coal-fired power fleet to almost double in size with an additional 27 GW by 2027 currently scheduled in the RUPTL. With the overall increasing electricity demand,[5] this leads to a change of the share of coal in the fuel mix of 62% in 2018 to 59% in 2027. Over this same period, around 15 GW of renewables will be added, which would lead to an increase in the power fuel mix of 11% to 20% in 2027. The intermediate target of 23% renewables in the power mix by 2025 (PWC, 2016) will according to the plan be met due to some large geothermal and hydropower plants coming online in 2025 (please refer to Box 2 where we discuss the concerns about broader sustainability of hydropower). This implies that after 2025 the share of renewables is expected to go down again due to limited addition of renewables and continued development of fossil power assets (Figure 9).

This is however partly compensated due to significant additions of coal-fired power in subsequent years. Mainly due to a downward revision of the annual increase of power demand, the new RUPTL had smaller overall capacity additions, with the largest cuts in gas-fired power and renewables compared to the previous RUPTL for 2017-2026. This means that the share of coal in the power mix is higher in the new plan and the share of renewables lower.

5 It should be noted that the RUPTL has shown to overestimate electricity demand growth projections. Demand growth for electricity over the period 2013-2018 averaged 4.6%, though the RUPTL projects this to be 6.9% per year towards 2027.

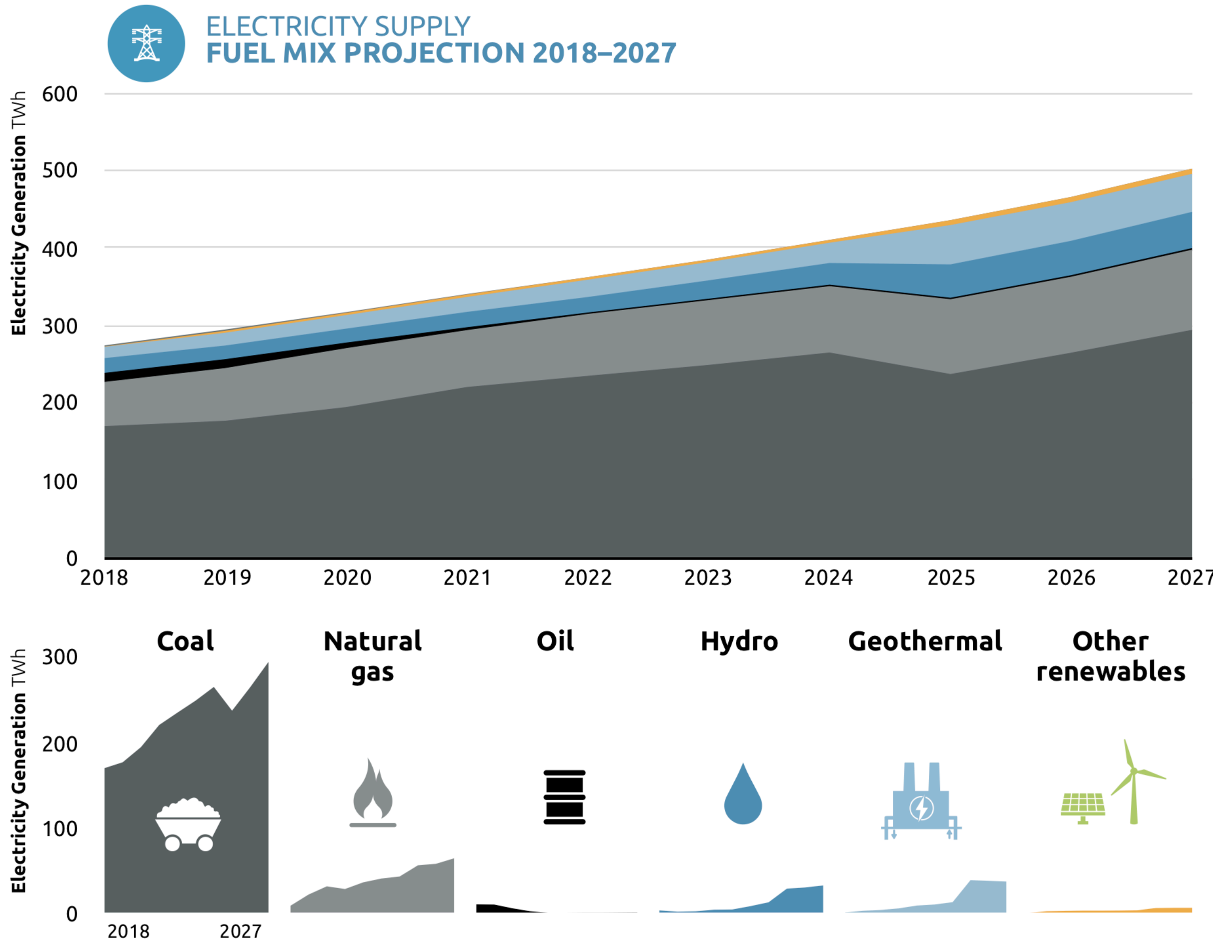


Figure 9: Fuel mix projection in the electricity sector as in RUPTL 2018-2027. Source: (PwC, 2018).

The government's **National Medium-Term Development Plan** (**RPJMN)** for 2015–2019, provides more specific targets on primary energy-related priorities such as the increased use of coal and gas, reduced dependency on oil and goals for biodiesel and bioethanol (Government of Indonesia, 2015). In addition, the Plan specifies that renewable energy should reach 10–15% of the energy mix by the end of the RPJMN period, concretely meaning 7.5 GW of new renewable electricity capacity up to 2019 (ADB, 2016). This is more ambitious than has been realised so far. According to the most recent RUPTL, around 2.6 GW of renewables had been constructed or are in planning stage (mid-2018). As indicated in Figure 9, based on both the RPJMN and RUPTL, the predicted share of variable renewables ("Other Renewables") is very limited, indicating that the government is not planning to develop the large potential the country has for these renewable power sources (especially solar PV). The RPJMN 2015–2019 also has a strong emphasis on energy infrastructure improvement, including targets on gas pipelines and LNG terminals. However, these targets are communicated as part of a broader strategy to reduce national greenhouse gas emissions by 26% compared to the baseline projection for 2019,[6] as specified in the National Action Plan for Greenhouse Gas Emission Reduction (RAN-GRK), which was adopted in 2011. The RPJMN also contains clear climate adaptation elements (Government of Indonesia, 2015).

In relation to Law No. 30/2007 on Energy and the 2014 National Energy Policy, President Widodo in 2017 signed an implementation regulation: **Presidential Regulation No. 22/2017 on the National General Energy Plan** (RUEN). The Plan is a cross-sectoral strategy which outlines the

[6] For reference, Indonesia's NDC mentions an unconditional reduction of 29% by 2030 and a conditional reduction of 41% below the baseline.

policies and strategies that will be implemented to achieve the targets set out under the National Energy Policy. The RUEN also contains energy demand and supply forecasts until 2050 as a foundation for the policies set out in the Plan.

2.1.2.2 Support scheme for renewables

Indonesia has various support schemes for renewables, such as feed-in-tariffs for geothermal, small hydropower, solar, bio-energy and waste-to-energy. These tariffs have recently been revisited in **Regulation 12/2017 on the Utilisation of Renewable Energy for the Provision of Power** and subsequent Regulation 43/2017 and 50/2017. This series of regulations provide a new mechanism for the stimulation of renewables' development, in which the feed-in-tariff is determined through negotiations between independent power producers (IPPs) and PLN by benchmarking against the regional average electricity generation cost. This creates uncertainty, since these average generation costs have been shown to differ from year to year, mainly reflecting changes in generation cost of coal-fired power. For regions where the average regional electricity generation cost is higher than the national average, the benchmark price for the feed-in-tariff will be 85% of the regional average cost. When the regional generation cost is lower or equal to the average national cost, negotiations with PLN take place to determine a maximum benchmark price. These changes generally see lower tariffs being paid to private developers compared to previous schemes and give more bargaining power to PLN, causing some projects to become commercially unviable (Horn & Sidharta, 2017). Also, renewable energy projects in regions with a low average generation cost may be disadvantaged compared to regions with a high average generation cost.

Ministerial Regulation No.12/2015 on the blending of biofuels is one of the most ambitious in the world, requiring companies holding a license to sell fuel to end users to achieve a 30% blending target by 2020. Sectors included are transportation, electricity, industry and commercial and micro-business, fisheries, agriculture and public services. The mandate means that the proportion of biodiesel blending in fuel sold to these sectors should be 30% in 2025 (and 20% bioethanol in transport and industry) (Rahmanulloh, 2018). For example, diesel contributes to around only 5% of Indonesia's energy mix for electricity generation, but is still the fuel of choice for smaller generators in many outer islands in eastern Indonesia (Asmarini & Munthe, 2016). The regulation is more ambitious compared to last versions, **Regulations 32/2008** and **25/2013**, which maintained lower targets (ICCT, 2016).

A main concern relates to sustainability of biofuel allowed to be used the current scheme. In general, oil palm plantations in Indonesia are required to comply with the Indonesian Sustainable Palm Oil (ISPO) certification scheme. The ISPO program covers greenhouse gas emissions (including methane capture), land use, biodiversity, and labour. But the current regulation specifically exempts palm oil plantations supplying palm oil for biofuel production from ISPO compliance (ICCT, 2016).

Tax incentives for renewable energy are also offered, through regulations such as **Regulation No. 21/PMK.011/2010** on Value-Added Tax and Import Duty Exemption for Renewable Energy Property, which exempts taxable goods imported to develop renewable energy projects from VAT and import duty (IEA, 2010).

2.1.3 Comparison of recent developments and projections to benchmarks

*2.1.3.1 **Actionable indicator No.1:** Growth of renewables and other zero and low carbon power*

Recent developments and projections under currently implemented policies suggest that Indonesia can sustaining its growth rates of renewables and other zero and low carbon power until 2027, which is expected to almost double in share, increasing from 12% in 2017 to 21% in

2027. In fact, compared to a historical growth of around 5% per year from 1990 to 2016, under the RUPTL planned growth of renewables accelerates to 14% per year in the period 2017 to 2027. However, given the significant increases in electricity demand and the associated capacity of fossil fuel-based power (mostly coal) that is being planned, Indonesia is not on a path of sustaining the growth of renewables in the power mix towards 2030 to meet full decarbonisation of the power sector in 2050. This is mainly because renewable additions post-2025 weaken and coal capacity additions are accelerated, while instead renewable energy deployment needs to be accelerated considerably (IRENA 2017).

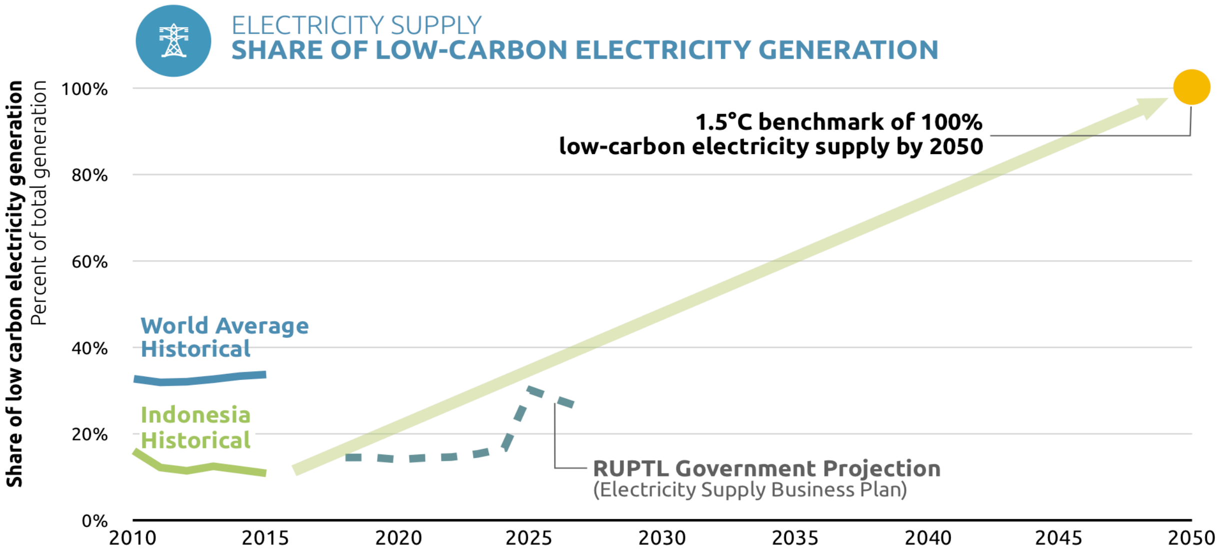


Figure 10: Historical and projected share of low carbon electricity generation in Indonesia

Growth in renewable electricity generation

Based on the 2018 RUPTL, PLN projected that power generation from renewables will increase from 30 TWh to 103 TWh in 2027, a more than three-fold increase. This means that the maximum share of renewables in the power mix under these plans would not exceed 20–21% by the end of this period, given a demand of 502 TWh. The main reason for this is a downward revision of the projected electricity demand towards 2027, and the cancellation of around 20 GW hydropower capacity, which brings the share of renewables down compared to the previous RUPTL. Although the renewables' share in Indonesia's power mix increases, especially the post-2025, coal capacity additions hinders Indonesia from achieving a 100% low-carbon energy system in 2050. In the long term, Indonesia doesn't have any specific targets to deploy renewables in the electricity supply mix beyond 2025. Indonesia's 2014 National Energy Policy sets a target of 31% renewables in the TPES in 2050, but this is cross-sectoral and does not apply to electricity only (PwC, 2018).

Indonesia has a significant renewable electricity generation potential, which was demonstrated in a study by the Directorate General of New and Renewable Energy and Energy Conservation (EBTKE, 2016). This confirms earlier independent assessments (Deng et al., 2015b). However, in practice only hydropower and geothermal sources currently make a meaningful contribution to the power system. Hydropower constitutes the largest renewable energy source in Indonesia and is projected to double towards 2026 from 6% in 2017 of the power mix (please refer to Box 2 where we discuss the concerns about broader sustainability of hydropower). Solar PV in 2018 is estimated to stand at an installed capacity of just 109 MW (Mulyana, 2016), and the total of bioenergy and solar PV together is expected to increase to 2 GW by 2027. The limited development of solar PV in Indonesia so far mainly relates to the following:

- As mentioned in Section 2.1.2., the power purchase prices are too low for investors to make sufficient returns. Purchase prices are capped at 85% of the regional average generation cost, which also contributes to tariff instability. This link with the average cost of generation also leads to competition of renewables with fossil power generation, and disregards the environmental and societal benefits of renewables.
- Frequent policy changes, regulatory delays and only partial implementation of government policy add to investor uncertainty.
- The role of PLN presents a number of conflicts, since it is also a fuel supplier for diesel generators and has little financial incentive to replace these installations with solar PV since this would affect their revenue.
- More fundamentally, another issue is that that the governmental bodies that have the largest influence over renewable energy policy generally have a lower support for renewable energy. This includes bodies like the Presidency, the Parliament, PLN and the Ministry of Energy and Mineral Resources (Bridle et al., 2018).

Indonesia also has an enormous geothermal potential which can also be of value in providing baseload power to the grid. Geothermal power production is projected to increase from 15 TWh in 2017 to 50 TWh in 2027. PLN has indicated that it will add 4.5 GW of geothermal capacity up to 2027, of which half will be tendered over the coming years. Indonesia has also been very slow in developing wind energy, with a first wind farm opened in 2018 (PwC, 2018).

Box 2: Hydropower and sustainability in Indonesia.

Box 2 Sustainability challenges related to the development of hydropower plants in Indonesia

Although hydropower is considered renewable and beneficial for emission reductions compared with fossil power, several large new hydro projects have raised important environmental and social concerns. It has been demonstrated that hydro plants can have large negative impacts such as disrupting river ecology, causing deforestation and loss of aquatic and terrestrial biodiversity, releasing substantial greenhouse gases, displacing thousands of people, and altering people's livelihoods plus affecting the food systems, water quality, and agriculture near them (Morana, et al., 2018).

A recent 510 MW hydropower project in Indonesia has raised public attention because of its potential impact on the habitat of the most critically endangered orangutan species[7]. A local court ruled that the construction of the Chinese-backed dam could continue, despite the concerns raised by a national environmental group.

The impact on the local population or on endangered orangutan species are relevant examples of the sustainability and social concerns that should be included when assessing the opportunity to further develop hydropower in Indonesia.

Growth of other zero and low-carbon technologies

Carbon capture and storage or nuclear energy are currently not planned as options in Indonesia's latest RUPTL which extends to 2027 (PwC, 2018). While there are no dedicated regulations for carbon capture and storage in Indonesia, like many oil and gas producing countries, aspects of the existing regulatory framework would be applicable or could be adapted to accommodate CCS. However, the Ministry of Energy and Mineral Resources did formulate several milestones related to carbon capture, utilization and storage in Indonesia. The ADB, Japan International Cooperation Agency (JICA) and Pertamina (the state-owned oil and gas company) are

7 https://www.stuff.co.nz/environment/111024397/indonesia-court-allows-dam-in-orangutan-habitat-to-proceed

collaborating on a pilot case in South Sumatra, which is scheduled to capture 29 ktCO_2 from a gas processing plant for enhanced oil recovery (EOR) (Indonesian Ministry of Energy and Mineral Resources, 2018a).

According to Presidential Decree 22/2017 on General National Energy Planning (RUEN), nuclear energy is mentioned as the last option that will be considered to meet Indonesia's future energy needs. Nuclear energy will only be considered if the 23% renewable energy target is not achieved after 2025 (Hidayatullah, 2017).

*2.1.3.2 **Actionable indicator No.2** - Reduce emissions from coal power plants*

Indonesia does not meet the 1.5°C compatible benchmark of not constructing new coal plants and reducing emissions from coal power by at least 30% by 2025 and does not acknowledge this benchmark given the increased reliance on coal-fired power capacity in the Electricity Supply Business Plan (RUPTL).

With its significant reserves, Indonesia is the world's largest exporter of steam coal. However, since the National Energy Policy went into force in 2014 Indonesia has shifted its focus to directing these fossil resources increasingly towards the domestic market. Between 2014 and 2018, coal production increased by 6% whereas domestic coal use increased by 59%. A large share of the increase in demand that is expected to double from 250 TWh in 2017 to 502 TWh in 2028, is expected to be met with new coal capacity. The most recent RUPTL foresees 27 GW of new coal-fired power capacity to come online by 2027 (PwC, 2018). According to the Global Coal Plant Tracker 34 GW of coal-fired power capacity has been announced or that is already in the pre-permit/permitting/construction phase.

According to RUPTL 2018, Indonesian power sector CO_2 emissions are projected to increase from 220 MtCO_2 in 2018 to 366 MtCO_2 in 2027 (+66%), primarily due to the growth in coal-fired power generation, since 80% of these emissions are projected to come from coal (Cornot-Gandolphe, 2017). This is a 97% increase in emissions from the power sector. The use of more efficient coal technology, such as supercritical and ultra-supercritical boilers is said to be a priority for PLN and the Indonesian Government in the development of additional coal-fired capacity, especially in the more densely populated regions like Java (PwC, 2018). A pilot-CCS project at the Gundih gas field in Central Java is scheduled to come online in 2019 to facilitate CCS knowledge development in Indonesia (Global CCS Institute, 2018).

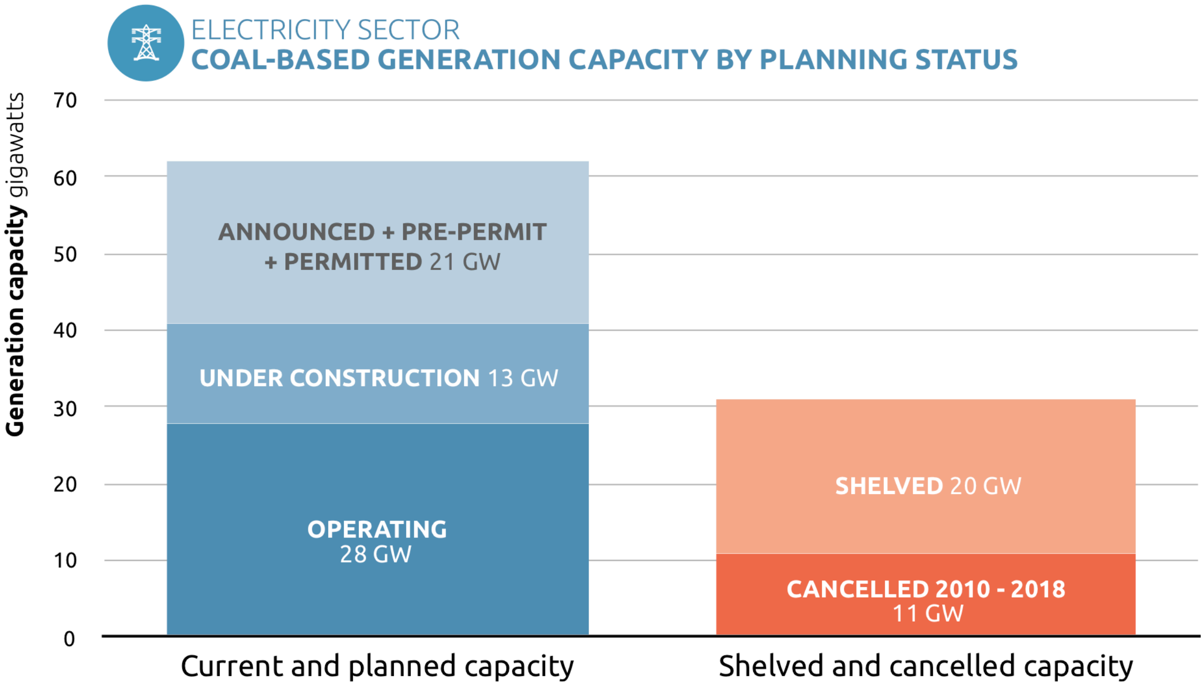


Figure 11: Current, planned and shelved/cancelled coal-based electricity capacity in Indonesia as of July 2018 (Endcoal, 2018).

2.1.4 Conclusion

Indonesia has frameworks in place to accelerate the deployment of renewable electricity sources but is lacking the right incentive for private investors to participate, especially with regard to decreasing project risk and needs to remove a range of barriers, including subsidies for coal (Bridle et al., 2018). At the same time, the country is experiencing a tremendous increase in electricity demand with a power grid that is already unable to cope with peak demand in some parts of the country. Although renewable energy capacity is projected to increase rapidly under the RUPTL, power demand will double over the 2018-2027 period and the RES share in the power mix is expected to reach a share of 20–21% because the largest increases in electricity demand is planned to be satisfied with coal-fired power – in stark contrast to the need to halt coal expansion, drastically reduce coal fired power generation and phase out coal. With these developments Indonesia is far away from heading to a 100% decarbonised energy system by 2050, especially given the planned coal power additions.

2.2 Transport sector

The Indonesian transport sector is experiencing significant structural changes mostly because of increasing welfare levels. The number of vehicles in Indonesia grew by 16% in 2013, compared to the year before (TCC, 2016). With emissions of 141 MtCO$_2$e in 2014, transport made up 16% of the country's total emissions (excl. LULUCF; 8% incl. LULUCF), and 23% of total energy-related emissions (Government of Indonesia, 2017). This makes the transportation sector responsible for the highest share of energy-related emissions, after the power sector. In the past, the final energy consumption of the transport sector grew at an average rate of 6.3% per year from 1990 to 2013. This growth is expected to continue up to 2040 under current policies, at a slightly lower rate of 5.2% per year (Malik, 2016). This expected growth makes the transportation sector an important focus area for energy conservation and emissions reduction.

Table 6: Indonesia's progress on the most important steps in the transport sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Transport sector	Last fossil fuel car sold before 2035	• Indonesia has an ambitious biofuel blending target of 20% in 2025 • Under current development, the *electric vehicles* share will remain marginal • Emissions from passenger vehicle transport are expected to increase by 28% from 2016 levels to 36 MtCO$_2$ in 2030. • Emissions from bus transport are expected to increase by 20% from 2016 levels to 71 MtCO$_2$ in 2030.	• A strong biofuel blending mandate ensures the decarbonisation of internal combustion engines on the short term, though sustainability standards are urgently needed • Indonesia is considering a ban on fossil-fuel car sales as of 2040, which is in line with 1.5C pathway specific for Indonesia • A Low Carbon Emission Vehicle (LCEV) programme is currently under development in which hybrid vehicles will be incentivised financially • Two-wheelers are the most popular form of transport across Indonesia. A transition to zero-carbon two-wheelers is therefore crucial, and the country projection shows a (very limited) uptake of EV two wheelers in 2030.	Getting Started
	Aviation and shipping: Develop and agree on a 1.5°C compatible vision	• Indonesia's RAN-GRK specifies GHG reduction targets for aviation: 11% below business-as-usual in 2020. • Emissions still increase significantly under RAN-GRK, from 11 to 17.9 MtCO$_2$ between 2015 – 2020 (+39%).	• Current policy scope is limited to short term and does not provide enough detail to qualify for a comprehensive 1.5°C compatible vision for the transport sector in Indonesia. • There are no strategies or policies on greener or sustainable maritime shipping in Indonesia	Getting Started

With 41 MtCO$_2$e, personal vehicle transport constituted a relatively small share of the total transport emissions in 2014, though having increased significantly from 11 MtCO$_2$ in the year 2000. Trucks were responsible for the dominant share of total transport emissions, emitting 57 MtCO$_2$e in 2014, an over 100% increase from 27% in 2000.[8] Aviation constitutes a rapidly growing, but smaller share of total transport emissions, increasing from 1.5 to 3.3 MtCO$_2$e over the period 2000–2014 as GDP increased. Train freight emissions are negligible.[9]

These developments illustrate Indonesia's needs to expand its transport infrastructure to meet demand, while simultaneously increasing transport efficiencies to reduce transport-related

8 Based on PROSPECTS Indonesia tool developed by Climate Action Tracker (2018)

9 Based on PROSPECTS Indonesia tool developed by Climate Action Tracker (2018)

emissions. Table 6 shows Indonesia's progress on the most important steps to decarbonise the transport sector to limit temperature increase to 1.5°C.

2.2.1 Actionable benchmarks in transport sector

The Climate Action Tracker identified two short-term actionable benchmarks for the transport sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- The last fossil car needs to be sold before 2035 to achieve car fleets consisting of 100% zero-emission cars by 2050.
- A 1.5°C compatible vision for the aviation and shipping needs to be developed and agreed upon.

With the findings from the IPCC report on achieving net-zero CO_2 emissions around 2050 and the rapid update electric vehicles of the last years in mind, this analysis decides to strengthen the benchmark for the vehicle sales to a fully 100% zero-emissions car stock by 2050, meaning the last fossil car needs to be sold before 2035.

The following gap analysis compares historical and projected developments in the Indonesian transport sector to these global benchmarks without any further adjustment to allow for comparison between countries under analysis. Country specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters on scaling up climate action. For a more detailed explanation on each indicator, please refer to Kuramochi et al., 2017.

Additionally, the freight transport needs to decarbonise: Freight trucks need to be almost fully decarbonised by around 2050 (Climate Action Tracker, 2018c).

2.2.2 Recent policy developments

Indonesia has implemented several climate strategies and policies in the transport sector, have been implemented to a variable degree.

Table 7 provides a comprehensive overview of the currently implemented and planned sectoral climate policies.

Below we describe Indonesia's key legislation in the transport sector, taken from

Table 7 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

Introduced in 2011, the **National Action Plan to reduce GHG emissions (RAN-GRK)** possibly represents the most important overarching GHG mitigation framework in Indonesia. The overall target is keeping emissions to 26% below business-as-usual by 2020 for all sectors covered in the Plan. The sectors within scope include: forestry and peat land, agriculture, energy and transportation, industry and waste management. The policy document is a national guideline and the provinces are expected to develop individual action plans themselves (LSE Grantham Institute, 2019). Specifically on transport, the RAN-GRK outlines plans for the development of a Bus-Rapid Transit (BRT) system, electrification of the railway system but also road pricing and eco-driving measures (Parikesit, 2014). RAN-GRK, also contains targets for the aviation sector. Measures around fleet regeneration, aviation biofuel use and 'eco-airports' are expected to reduce emissions from the sector by 11% below business-as-usual in 2020. However, emissions still increase under the Plan, from 11 to 18 $MtCO_2$ between 2015–2020 (+39%) (Ministry of Transportation-Indonesia, 2012).

Table 7: Overview of implemented climate change policies in the transport sector in Indonesia

OVERVIEW OF EXISTING AND, PLANNED CLIMATE CHANGE POLICIES FOR THE TRANSPORT SECTOR IN INDONESIA				
Changing Activity	**Energy efficiency**	**Renewables**	**Modal switch**	**Non-energy**
Urban planning and infrastructure investment to minimize transport needs ▪ Development of high-speed train and metro on the Jakarta region	**Minimum energy/emissions performance standards or support for energy efficient for light duty vehicles** ▪ MoEF Regulation No. 04/2009	**Biofuel target** ▪ Biofuel Supply, Utilization and Trading (Ministerial Regulation No. 32/2008) ▪ Biofuel Blending (Ministry Regulation No. 25/2013) ▪ Ministerial Regulation No.12/2015 -Biofuels Mandate (2015)	**E-mobility programme** ▪ Low Carbon Emission Vehicle program (LCEV) (announced) (2018)	
Support for modal share switch ▪ Sustainable Urban Transport Programme Indonesia (NAMA SUTRI) (2012) Transport Ministerial Regulation No. 201/2013 (2013)	**Minimum energy/emissions performance standards or support for energy efficient for heavy duty vehicles** ▪ (none)	**Support schemes for biofuels** ▪ Development credits for biofuels and plantation revitalisation (2007)	▪	
		Sustainability standards for biomass use (none)		
Tax on fuel and/or emissions ▪ Automotive Fuel Tax (2010)				
Fossil fuel subsidies ▪ (none)				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Indonesia could adopt policies from other countries

Existing and planned policies for Indonesia

2.2.2.1 Support for modal share switch

In collaboration with GIZ, the Ministry of Transport in 2012 developed the **Sustainable Urban Transport Programme Indonesia** (NAMA SUTRI). The programme is structured around two phases: piloting (2015–2019) and full-scale implementation (2020–2030). The key measures taken under the programme include: public transport system improvement, investments in energy-efficient buses, investments in infrastructure and improved planning. The projected GHG mitigation effect of the programme is 18.6–73 $MtCO_2$ over the period 2020–2030. Five pilot cities were selected and asked to develop demonstration projects around the improvement of public transport, mainly around Bus-Rapid Transit systems, and transport demand management and is projected to have a direct impact of 0.9–1.8$MtCO_2e$/year in 2030, accumulated over the five pilot cities (GIZ, 2017).

In addition, **Ministerial Regulation 201/2013** aims to mitigate transport emissions through an “avoid, shift and improve” approach. Policies under the regulation are primarily focused on fuel shifting from oil to gas and modal shift, such as car-free days on weekends, transit-oriented development planning and stimulating the use of non-motorised vehicles (Fulton, Mejia, Arioli, Dematera, & Lah, 2017).

The **Master Plan Acceleration and Expansion of Indonesia Economic Development 2011-2025 (MP3EI)** sets out a plan with the aim of transforming Indonesia into a top ten economy globally in 2025. It sets out priorities for economic growth, where one key focus is on strengthening national connectivity locally and internationally. Under this pillar, it sets out aims for the freight transport sector, including a shift towards multi-modal transportation and away from more emission-intensive road transport (Coordinating Ministry for Economic Affairs, 2011).

2.2.2.2 Biofuel target

Ministerial Regulation No.12/2015 on the blending of biofuels is one of the most ambitious in the world, requiring companies holding a license to sell fuel to end users to achieve a blending target of 25% by 2025. The four sectors included are 1) transportation, 2) electricity, 3) industry and commercial and 4) micro-business, fisheries, agriculture and public services. The regulation sets more aggressive blending targets compared to previous versions, **Regulations 32/2008** and **25/2013** (ICCT, 2016). Internationally, the sustainability of this biofuel mandate is debated, since clearing of forests for palm oil plantations disproportionally increases greenhouse gas emissions from the LULUCF sector (refer to Box 3) (Goodman & Mulik, 2015; ICCT, 2016; Jaung et al., 2018; Khatiwada, Palmén, & Silveira, 2018; Statistics Indonesia, 2015). To facilitate the implementation of this target, biofuel subsidies are provided from the Indonesia Oil Palm Estate Fund (BPDP). This is a variable subsidy, based on the price differential between fossil-based diesel fuel and biofuels, as defined by the Market Price Index (MPI). The MPI is regulated through the Ministry of Energy. The ICCT stresses, however, that in practice there is little enforcement of the biofuel target and that based on past experiences with such targets it is likely that implementation will lag behind the envisioned goals(Cornot-Gandolphe, 2017).

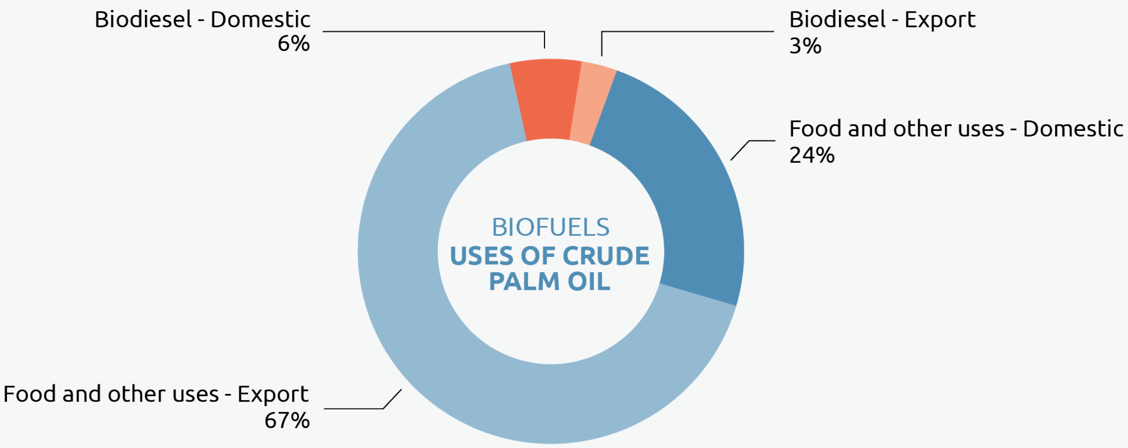
Box 3: Biofuels production and sustainability in Indonesia.

Box 3 Sustainability challenges related to the development of biofuel production in Indonesia

The use of crude palm oil (CPO) for the production of biofuels for the European market has raised concerns about its sustainability and especially about the high risk for (indirect) land use change leading to deforestation and expansion of agricultural land into peatland. This use of CPO in the European Union will likely be limited under the new Renewable Energy Directive adopted in 2018. Indonesia is the world's largest producer of CPO, and palm oil plantations in 2015 extended over 11 million hectares, which have expanded on average with 0.5 million hectares per year (Statistics Indonesia, 2015). On average, 70% of this CPO is exported and only 12% of the total is used for biofuels production. Historically, significant areas of primary forest, some of which situated on peatland, have been cleared for palm oil plantations. Both the deforestation and the drainage of these peatlands result in significant greenhouse gas emissions and increased susceptibility to wildfires, which, besides damaging the environment, are also a public health hazard. Approximately 20% of wildfires in Indonesia can be attributed directly to oil palm plantation practices.

To improve the sustainability of CPO production, the government has installed a moratorium in 2011 on clearing forest on peatland and requires plantation owners to comply with the Indonesian Sustainable Palm Oil (ISPO) certification scheme. However, compliance with this scheme is voluntary for smallholder plantation owners, which produce 40% of the palm oil in Indonesia. Ministry of Agriculture's Regulation No.11/2015 has also specifically exempted CPO production for biodiesel from compliance with ISPO. These exemptions will likely limit the effectivity of sustainability safeguards of Indonesian biodiesel.

One option to meet the growing demand for biodiesel sustainably, is to expand plantations to degraded lands, since this may lead to an increase of carbon stocks. Jaung et al. found that around 3.5 million hectares of such land could be available to farm biodiesel feedstocks (Jaung et al., 2018). These land sizes however do not seem large enough to support economies of scale required for biofuels production. Alternatively, offshore algae farming for biodiesel production could offer additional potential towards 2030. The traditional practice of logging forests for palm oil conversion gave land owners an interesting business case, while the more sustainable options are typically costlier. Therefore, a sustainable increase of biofuels feedstock production will require strong support measures. Another option to partly meet domestic and international demand is to focus efforts on increasing CPO yields, which are on average 20% below yields in neighbouring Malaysia. Finally, since Indonesia is producing considerably more CPO than it is consuming, policies could also be considered that divert exports to the domestic market, although this would have to be weighed against the economic impacts.



2.2.2.3 E-mobility programme

In early 2017, Industry Minister Airlangga Hartarto announced that the Indonesian Government is preparing a **Low Carbon Emission Vehicle (LCEV) programme**. An important element of the policy will be the provision of tax breaks for hybrid vehicles (Suzuki, 2017). This programme will be a follow up of the Low-Cost Green Car (LCGC) programme, which exempts low-cost and energy-efficient cars from luxury sales tax (Automotive World, 2016). The Indonesian Ministry of Energy and Resources said in August 2017 that a ban on fossil-fuel vehicles would be introduced in the draft Presidential regulation of the LCEV programme for the year 2040 (Kumparan, 2017; Tinuku, 2017). The draft Presidential regulation has however not been published to date as the government is debating over the measures to stimulate electric vehicles.

2.2.2.4 Tax on fuel and/or emissions

Taxation and fuel subsidies are a relevant topic in Indonesia, associated with much controversy. Transportation accounts for nearly all of the subsidised fossil-fuel consumption and the consistent under-pricing of fuel has led to a strong demand for vehicles—mainly cars and motorcycles—over the past decade, leading to congestion and air pollution (IEA, 2016). Price reforms in early 2015 removed subsidies for gasoline and fixed subsidy levels of diesel at USD 0.08 per litre. Total levels of subsidy decreased by around 75% between 2014 and 2015 to a level of 60 trillion IDR (around 4.3 billion USD) (Sambijantoro, 2015). Indonesia's **Automotive Fuel Tax** is imposed in the form of a 5% tax on vehicle fuel sales, but may differ per province (OECD, 2015).

2.2.3 Comparison of recent developments and projections to benchmarks

*2.2.3.1 **Actionable indicator No.3:** Last fossil fuel car sold before 2035*

The rapid introduction of zero-emissions vehicles is key to achieving the decarbonisation of the transport sector with the last fossil fuel car being sold before 2035. Climate Action Tracker has defined an Indonesia specific 1.5°C compatible benchmark has being "the last fossil fuel car being sold before 2040". Within the context of Indonesia, no such framework has been implemented to date, although a Low Carbon Emission Vehicle (LCEV) programme is currently under development in which hybrid vehicles will be incentivised financially. In addition, the Indonesian Ministry of Energy and Resources made clear that a ban on fossil-fuel vehicles would be introduced in the draft presidential regulation of the LCEV programme for the year 2040. If this proposal is adopted, Indonesia's policy would be compatible with the 1.5°C benchmark. Regarding the remaining internal combustion engine (ICE) vehicles, there is a transition ongoing towards more low-carbon transport driven by the biofuel mandate.

Consuming 23% of all transport fuels, two-wheelers are the most popular form of transport across Indonesia. Looking at developments in this mode of transport is therefore crucial in the country-specific context. Domestic mass production of electric two-wheelers is currently initiating, with the first models having entered the market in 2017 (IEA, 2017a).[10] The National Energy Plan envisages 184 million motorcycles on the road in 2030, of which 4 million should be electric motorcycles. That represents only 2% of the total fleet and is far from what would be needed to reach the same level as the car benchmark.

*2.2.3.2 **Actionable indicator No.4**: Develop a 1.5°C compatible vision in aviation and shipping*

Aviation

Within the RAN-GRK, targets are also set out for the aviation sector. Measures around fleet regeneration, aviation biofuel, use and 'eco-airports' are expected to reduce emissions from the sector by 11% below business-as-usual in 2020. However, emissions still increase significantly under the Plan, from 11 to 17.9 $MtCO_2$ between 2015 – 2020 (+39%) (Ministry of Transportation-Indonesia, 2012). This is visible from an expected compound annual growth rate (CAGR) of 4.8% in passenger km per capita over this period (IEA, 2017).

10 http://www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf

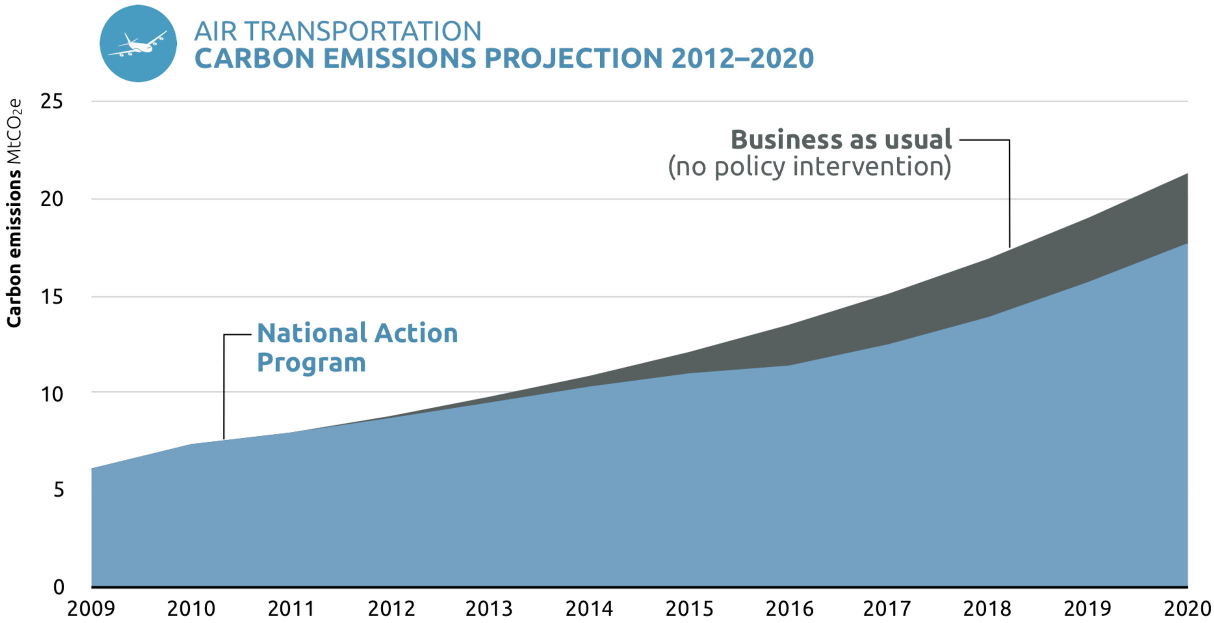


Figure 12: GHG emissions projections for the Indonesian aviation sector between 2009 and 2020, taking into account the measures under the National Action Program Air Transportation 2012-2020 (Ministry of Transportation-Indonesia, 2012).

Maritime shipping

No strategy or policies on greener maritime shipping exist in Indonesia. In the RAN-GRK, measures are suggested for shipping such as reduced speed, optimised load, fleet maintenance and improved planning. Responsibility on efficiency standards are transferred to the jurisdiction of the IMO (BAPPENAS, 2011). Indonesia is a member of the International Maritime Organization (IMO), which engages in emission reduction through the following measures (IMO, 2017):

i. Adoption of regulations to address the emission of air pollutants from ships
ii. Adoption of mandatory energy-efficiency measures to reduce emissions of greenhouse gases from international shipping
iii. Global capacity-building projects to support the implementation of those regulations and encourage innovation and technology transfer

No information or analysis exists to which degree Indonesia engages in these different work streams and whether these initiatives might reduce emissions from the Indonesian maritime transport and fishing sectors. In April 2018, the IMO strategy on emission reduction was accepted, which includes the goals of reducing emissions from international shipping by 50% by 2050 compared to 2008 and a complete phase out “as soon as possible in this century” (ICCT, 2018).

Freight transport

Indonesia’s MP3EI Connectivity Vision 2025 sets out aims for the freight transport sector, in which they outline a shift towards multi-modal transportation and away from more emission-intensive road transport (Sinaga, 2013). It is unclear whether and to which degree this intended modal shift in freight transport and required infrastructure improvements can be realised in the near to medium-term.

Freight transport related emissions are expected to increase substantially under currently implemented policies, caused by an average freight transport activity growth of 4% per annum (*World Population Prospects: The 2012 Revision*, 2012).[11] It should be noted, however, that these

11 Based on PROSPECTS Indonesia tool developed by Climate Action Tracker (2018)

are ASEAN average figures and may not be fully representative for the Indonesian context. Road freight transport accounted for around 90% of the total land-based freight transport in 2015, with only 10% transported by rail and is projected to increase to 92% and 8% by 2030, respectively (ADB, 2016; Statistics Indonesia, 2015). However, part of the emissions growth should be offset by the increase in biofuel use, which is projected to increase from 12% in 2015 to 30% in 2030 (ICCT, 2016).

2.2.4 Conclusion

Based on the analysis of recent national plans and targets and with adequate implementation, the Indonesian transport sector could meet the first 1.5°C compatible benchmark, which requires that the last fossil car be sold before 2035-2040 to achieve car fleets consisting of 100% zero-emission cars by 2050. The Indonesian Ministry of Energy and Resources made clear that a ban on fossil-fuel vehicles would be introduced in the draft presidential regulation of the LCEV programme for the year 2040. However, this draft presidential regulation is only expected in in the course of 2019. This regulation is in the context of the Low Carbon Emission Vehicle programme, aimed at incentivising low-carbon and electric vehicles. Remaining ICEs are subject to an aggressive biofuel mandate, in which a 30% blending target is set for 2030. Sustainability of palm oil biodiesel is a contentious topic in Indonesia, and sustainability safeguards should be improved to ensure land-use emissions are much lower than the fossil equivalent.

The RAN-GRK also indicates planned efforts to mitigate GHG emissions in the aviation sector. However, the scope is limited to 2020 and does not provide enough detail to qualify for a comprehensive 1.5°C compatible vision for the transport sector in Indonesia.

2.3 Buildings sector

The buildings sector accounted for 42% of Indonesia's final energy consumption in 2012. Residential buildings are by far the biggest contributor to final energy consumption in the buildings sector, representing around 95% of the total. Commercial buildings make up the rest and account for 5% (IEA, 2018b). Traditional biomass is still commonly used for cooking and heating, especially in poor households, although the population is slowly switching to LPG for cooking and electricity through the use of modern electric appliances. Electrification has led to an increase in electricity demand by a factor three over the period 2000–2015 (IEA, 2017f).

GHG emissions from the buildings sector amounted to around 138 $MtCO_2$ in 2014, of which 77% were indirect emissions from the power sector allocated to energy use in buildings. These total emissions constitute around 15% of Indonesia's total GHG emissions (excl. LULUCF; 7% incl. LULUCF) (Dewi, 2015b). Between 1990 to 2015, the buildings emission intensity per capita increased by 211%, considerably faster compared to the average global increase of 14% (Climate Action Tracker, 2017a).

Table 8 summarises Indonesia's progress on the most important steps to decarbonize the buildings sector to limit temperature to 1.5°C.

Table 8: Indonesia's progress on the most important steps in the buildings sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Buildings sector	All new buildings fossil free and near zero energy by 2020	• No country specific projections available	• Although buildings emissions intensity is on the rise, the current level is around 0.5 tCO_2/capita (2014). That is half of the global average and represents the intensity level that is required in 2020 to be consistent with a 1.5°C-pathway. • Indonesia is introducing green building standards (for commercial and public buildings) in its major cities and is therefore making good progress towards having its cnew buildings fossil free and near-zero energy by 2020. • Residential sector is the most important sub-sector in terms of energy use, and is lacking ambitious standards.	Getting Started
	Increase building renovation rates from <1% to 3% by 2020	• No country specific data available	• There is some development in policies for building renovation in Indonesia, but due to the rapidly increasing welfare levels and a high new build rate, renovation of existing buildings is underemphasised in Indonesia. • This also means that Indonesia will most likely not meet the benchmark of increasing building renovation rates from <1 to 5% by 2020	No Action

2.3.1 Actionable benchmarks in buildings sector

The Climate Action Tracker identified two short-term actionable benchmarks for the buildings sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- All new buildings ought to be fossil-free and near zero energy by 2020.
- The annual retrofit rates of existing building stock need to increase from less than 1% in 2015 to 5% by 2020.

The following gap analysis compares historical and projected developments in the Indonesian buildings sector to these global benchmarks without any further adjustment to allow for comparison between countries under analysis. Country specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters. Please refer to the publication for more detailed explanation on each indicator.

2.3.2 Recent policy developments

Indonesia has implemented several climate strategies and policies in the transport sector, which have been implemented to a variable degree. Table 9 provides a comprehensive overview of the currently implemented and planned sectoral climate policies.

Table 9: Overview of implemented climate change policies in the buildings sector in Indonesia

OVERVIEW OF EXISTING, PLANNED AND POTENTIAL CLIMATE CHANGE POLICIES FOR THE BUILDINGS SECTOR IN INDONESIA				
Changing Activity	**Energy efficiency**	**Renewables**	**Nuclear or CCS or fuel switch**	**Non-energy**
Urban planning strategies (none)	**Building codes and standards and fiscal/financial incentives for low-emissions choices** ▪ Law No. 36/2005 on Buildings (2005) ▪ Government Regulation No. 36/2005 ▪ Regulation concerning criteria/certification of Green Building (2010) ▪ Jakarta Regulation No. 38/2012 on Green Buildings (2012) ▪ National Energy Conservation Master Plan (RIKEN) (2005; amended 2014)	**Support scheme for heating and cooling** ▪ (none)		
	Minimum energy performance and equipment standards for appliances ▪ Regulation concerning efficiency standard for electricity consumption in office building (2012) ▪ MEPS and Labelling for Air Conditioning (Ministerial Regulation No.07/2015) (2015) ▪ Presidential regulation 70/2009 concerning Energy Conservation (2009)	**Support scheme for hot water and cooking** ▪ (none)		
		Sustainability standards for biomass use (none)		
Energy and other taxes ▪ (none)				
Fossil fuel subsidies • (none)				

(light grey)	*No policies currently exist and a similar policy gap exists in all other countries*
(grey)	*No policies currently exist however Indonesia could adopt policies from other countries*
(light blue)	*Existing and planned policies for Indonesia*

Below we describe Indonesia's key legislation in the buildings sector, taken from Table 9 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

2.3.2.1 Building codes and standards and fiscal/financial incentives for low-emissions

Law No. 36/2005 and **Government Regulation No. 36/2005** made it mandatory for new buildings to take into account energy conservation measures, with the exception for buildings smaller than 500 m^2. However, there have been difficulties with enforcing compliance with existing standards. Subsequent revisions to the law stated that complex buildings (e.g., offices, industrial facilities and buildings consuming more than 6,000 tonnes of oil equivalent per year) must conduct energy management programs and activities, such as hiring an energy manager, conducting an energy audit and preparing energy conservation plans and reports (IPEEC, n.d.).

Indonesia has four building standards in place, that apply to residential buildings that are over 500 m^2 and have more than eight stories with a basement:

- **SNI 03-6389-2000**: Energy conservation for building envelope of buildings
- **SNI 03-6390-2000**: Energy conservation for air conditioning systems in buildings
- **SNI 03-6197-2000**: Energy conservation for lighting systems in building structures
- **SNI 03-6196-2000**: Energy auditing procedure for buildings

More recently, the Special Capital City District (DKI) Jakarta has introduced the first mandatory green building regulation through **Regulation No. 38/2012 on Green Buildings**. The Ministry of Public Works (MoPW) has recently also developed National Guidelines on Green Buildings for local governments to more easily implement green building standards in other large cities throughout Indonesia. The MoPW stated that these National Guidelines should focus on: i) reducing CO_2 emissions from the building sector in 2020; ii) certifying 50% of total state-owned buildings as green buildings; iii) improving overall energy efficiency by 20%, water efficiency by 20% and waste reduction in low-cost houses by 20% (IPEEC, n.d.). Key milestones for the coming years include capacity building for local governments, establishment of green building baseline data and setting up data management systems. Enforcement of all building regulation is done through state and local government.

The **National Energy Conservation Master Plan (RIKEN)**, developed by the National Energy Council, has an overall target of decreasing energy intensity of buildings by 1% per year until 2025. First introduced in 2005, it was amended in 2014 to update conservation potentials. The energy savings target for households and commercial buildings was set at 15% below business-as-usual by 2025, but also includes targets for transportation and industry. An additional goal of RIKEN is to achieve an energy elasticity of less than 1 by 2025, meaning that GDP should increase faster than the energy consumption (IPEEC, 2019).

Under Indonesia's overarching National Energy Conservation Strategy, **Presidential Regulation 70/2009 concerning Energy Conservation** puts forward an Energy Efficiency Labelling Program to inform consumers about the energy efficiency level of electric appliances. Under this regulation, there is also the obligation for large consumers to conduct energy audits. In practice, a lack of labs for testing has been an issue for Indonesia (IPEEC, n.d.).

Ministerial Regulation No.12/2015 on the blending of biofuels is one of the most ambitious in the world, requiring companies holding a license to sell fuel to end users to achieve a blending target of 30% by 2020. The four sectors included are 1) transportation, 2) electricity, 3) industry and commercial and 4) micro-business, fisheries, agriculture and public services. Emissions from fuel combustion in the buildings sector in 2014 were 35 $MtCO_2e$. Part of these fuels will be substituted with biofuel-blended fuel. The regulation sets more aggressive blending targets compared to last versions, **Regulations 32/2008** and **25/2013** (ICCT, 2016).

2.3.3 Comparison of recent developments and projections to benchmarks

In the following section, the actionable indicators relevant to the buildings sectors will be assessed against the policies and projections in place in Indonesia. It should be noted that data on residential buildings in Indonesia is scarce, and that policy is currently mostly focused on commercial buildings. Also, given rapidly increasing welfare levels and a high new build rate, renovation of existing buildings is somewhat underemphasised in Indonesia.

Actionable indicator No.5: *All new buildings fossil free and near zero energy by 2020*

Indonesia shows good progress on this actionable indicator in public and commercial buildings, primarily through its green buildings policies. However, no framework exists to date in which energy-efficiency or decarbonisation measures are stimulated in residential buildings, only in residential buildings that are over 500 m^2 and have more than eight stories with a basement. This makes sector-wide progress on this indicator marginal, since the residential sector is by far the biggest contributor to final energy consumption, with around 95% of total buildings energy use.

Buildings emissions intensity per capita in Indonesia has increased from 0.3 tCO_2/capita in 2000 to 0.5 tCO_2/capita in 2015 (Climate Action Tracker, n.d.). Although this growth is significant, the absolute level is still well below the global average of 1 tCO_2/capita, which is also the intensity required in 2020 to be consistent with a 2°C-pathway (Wouters et al., 2016).

The energy intensity in the residential sector at floor area (kg CO_2/m^2) has improved by 14% from 23 $kgCO_2/m^2$ in 2005 to 20 $kgCO_2/m^2$ in 2010. A slightly stronger reduction of 16% was observed over this period in the commercial buildings sector.

Indonesia's capital of Jakarta is relatively advanced in green building policy for large buildings. In fact, the world's first zero-energy skyscraper is currently being constructed in Jakarta (SOM, 2016). Standards were enforced through **Regulation No. 38/2012 on Green Buildings**, which come with National Green Building Guidelines that should facilitate implementation throughout the country. Monitoring compliance has been difficult, since Indonesia does not have methodologies to assess its compliance programs yet, given how new the mandatory requirements are. The city of Bandung followed Jakarta by implementing even more stringent mandatory standards that are applicable to all buildings (IEA, 2017a). Indonesia is also a member of the World Green Building Council, which has been responsible for the development of a voluntary green ratings tool to evaluate the environmental design and construction of buildings (Panasonic, 2016). In relation to Indonesia's NDC pledge of reducing GHG emissions by 29% in 2020, the government has said that increasing the number of green buildings in Jakarta is crucial to helping the city reach this goal (Eco-Business, 2012). However, the city of Jakarta as a whole only consumes around 5% of the primary energy in Indonesia.

The electricity that is used by buildings is also gradually decarbonised, through for example the increased uptake of renewables. However, by 2020 the electricity produced in Indonesia still has a high emission factor. Indonesia's RUPTL states that current grid emissions factor is 0.851 $kgCO_2$/kWh, and foresees this to decrease to 0.749 $kgCO_2$/kWh in 2025 (Indonesian Ministry of Energy and Mineral Resources, 2016). At the same time, households are increasingly switching from biomass to LPG and kerosene as a heating fuel. We can therefore conclude that in the commercial and public buildings domain, Indonesia is making good progress, but that the residential sector is lagging behind in meeting the actionable indicator. Unfortunately, this is also where the largest impact could be made, since residential buildings are by far the biggest contributor to final energy consumption, making up around 95% of the buildings sector energy consumption.

2.3.3.1 ***Actionable indicator No.6:*** *Increase building renovation rates from <1 to 5% by 2020*

Building renovation rates for Indonesia are unknown. DANIDA, the International Development Agency of Denmark, has a number of programs that support the Indonesian government in designing the incentive program for retrofits. Regarding retrofit/renovation policy, the draft National Green Building Guidelines only requires building audits and implementation of green requirements when feasible. We can therefore conclude that there is some minor movement in the building renovation market in Indonesia, but due to the rapidly increasing welfare levels and a high new build rate, renovation of existing buildings is underemphasised in Indonesia. This also means that Indonesia will most likely not meet the benchmark of increasing building renovation rates from <1 to 5% by 2020.

2.3.4 Conclusion

Indonesia is introducing mandatory green building standards in Jakarta and the Ministry of Public Works is actively developing green building guidelines to support major cities to also implement these. Indonesia is therefore making good progress towards having its new commercial and public buildings fossil free and near-zero energy by 2020. However, the residential sector is the most important sub-sector in terms of energy use and emissions, and is lacking ambitious standards for all residential buildings. Grid electricity intensity is projected to remain high at levels of 0.749kg CO_2/kWh in 2025, meaning that it will be also difficult to decrease residential indirect emissions as required by the benchmark. Electricity supply sector decarbonisation is therefore crucial for the decarbonisation of Indonesia's buildings sector.

Although building emissions intensity is on the rise with the current level at around 0.5 tCO_2/capita in 2014. That is half of the global average and represents the intensity level that is required in 2020 to be consistent with a 1.5°C-pathway.

There is some minor movement in the building renovation market in Indonesia, but due to the rapidly increasing welfare levels and a high new build rate, renovation of existing buildings is underemphasised in Indonesia. This also means that Indonesia will most likely not meet the benchmark of increasing building renovation rates from below 1 to 5% by 2020.

2.4 Industry sector

Direct energy-related GHG emissions for Indonesia's industry sector amounted to 172 $MtCO_2$ in 2014, with process emissions from industry adding another 47 $MtCO_2$. This makes the industry sector responsible for 25% of total emissions (excl. LULUCF; 12% incl. LULUCF) (Government of Indonesia, 2017). Final energy demand has increased by some 43% since 2000, to 57 million toe in 2012 (Dewi, 2015b). According to the RUPTL, power demand in the industry is expected to double between 2016 and 2025 (Indonesian Ministry of Energy and Mineral Resources, 2016).

In 2005, half of the industry sector's GHG emissions were attributable to four sectors: non-metallic minerals (18%), textiles (13%), basic metals (13%) and food and beverages (8%) Figure 13) (Indonesian Ministry of Finance, 2009). In terms of economic output, the pulp and paper sector also represent an important export industry. In this report, the term "industry sector" refers to all activities that fall under the categories of manufacturing, mining and construction.

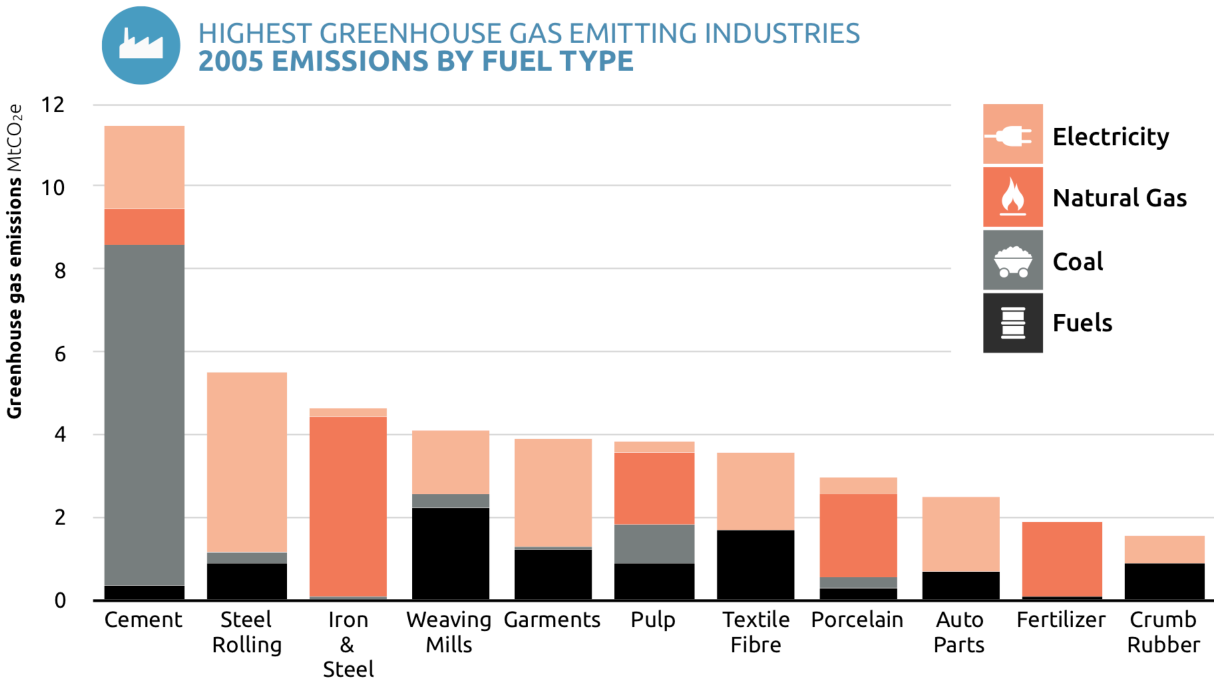


Figure 13: Sub-sector GHG emissions, by primary energy source (Indonesian Ministry of Finance, 2009).

Table 10: Indonesia's progress on the most important steps in the industry sector to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
Industry sector	All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency	• According to the RUPTL, energy sales in the industry are expected to double between 2016 and 2025. • Without a significant reduction of energy emissions intensity, this would imply a doubling of energy-related industry emissions.	• Indonesia's cement and steel sectors have shown initiative to enhance material efficiency and decarbonise their production processes. • Some specific policies have been formulated for the cement sector and some goals have been specified for some sub-sectors but the benchmark is not yet within reach in Indonesia, even for the steel and cement sectors	

2.4.1 Actionable benchmarks in industry sector

The Climate Action Tracker identified one short-term actionable benchmark for the industry sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- All new installations in emissions-intensive sectors need to be zero or low carbon after 2020 such as zero-carbon steelmaking technologies, including carbon capture and storage (CCS) and material efficiency needs to be maximized.

The following gap analysis compares historical and projected developments in the Indonesian industry sector to this global benchmark without any further adjustment to allow for comparison between countries under analysis. Country specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters. Please, refer to the publication for more detailed explanation on each indicator.

2.4.2 Recent policy developments

Table 11 provides an overview of implemented policies that foster the development towards a low-carbon industry in Indonesia.

Below we describe Indonesia's key legislation in the industry sector, taken from

Table 11 and structured according to the policy categories. Only the most impactful policies are discussed. In the descriptions, the main aims of the policies are introduced as well as their envisioned effects.

Introduced in 2011, the **National Action Plan to reduce GHG emissions (RAN-GRK)** represents the most important overarching GHG mitigation framework in Indonesia. The overall target is 26% below business-as-usual by 2020 for all sectors covered in the Plan. It touches upon different sectors in which Indonesia will make emissions reductions: forestry and peat land, agriculture, energy and transportation, industry and waste management. The policy document is a national guideline and the provinces are expected to develop individual action plans themselves. Specifically on industry, the RAN-GRK outlines a focus on improvements of energy efficiency and the increased use of renewable energy (BAPPENAS, 2016). Sub-sector targets include a 17.4% reduction in GHG emissions for the cement sector relative to a “business as usual” scenario between 2006 and 2025, and a 15.4% reduction for the iron and steel industry.

Table 11: Overview of implemented climate change policies in the industry sector in Indonesia.

OVERVIEW OF EXISTING, PLANNED AND POTENTIAL CLIMATE CHANGE POLICIES FOR THE INDUSTRY SECTOR IN INDONESIA				
Changing Activity	**Energy efficiency**	**Renewables**	**CCS or fuel switch**	**Non-energy**
Strategy for material efficiency ▪ CO2 Emissions Reductions in the Cement Industry (Industrial Minister Regulation No. 12/2012) (2012)	**Support for energy efficiency in industrial production** ▪ Ministerial Regulation 14/2012 concerning Energy Management (2012)	**Support schemes for renewables** ▪ Biofuel Blending (Ministry Regulation No. 25/2013) (2013)	**CCS support scheme** (none)	**Landfill methane reduction** (none)
	Energy reporting and audits ▪ Ministerial Regulation 14/2012 concerning Energy Management (2012) ▪ Presidential regulation 70/2009 concerning Energy Conservation (2009)	**Sustainability standards for biomass use** (none)		**Incentives to reduce CH4 from oil and gas production** (none)
	Minimum energy performance and equipment standards ▪ CO2 Emission Reductions in the			**Incentives to reduce N2O from industrial processes** (none)
				Incentives to reduce fluorinated gases (none)
Overarching carbon pricing scheme or emissions limit (none)				
Energy and other taxes ▪ (none)				
Financial Support Schemes for Sustainable Development (none)				
No fossil fuel subsidies ▪ (none)				

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Indonesia could adopt policies from other countries

Existing and planned policies for Indonesia

2.4.2.1 Minimum energy performance and equipment standards

Regarding energy reporting and energy audits, **Ministerial Regulation 14/2012 concerning Energy Management**, all large energy consumers—defined as an energy consumption of more than 6 ktoe—are required to conduct energy audits periodically.

Specifically for the Indonesian cement sector, the Ministry of Industry has put forward a regulation in 2012 (**Regulation Concerning CO_2 Emission Reductions in the Cement Industry**).

The aim of the policy is to reduce the emissions intensity of cement production by 2% from 2011 to 2015 and by another 3% from 2016 to 2020, below 2009 levels. The Ministry will be involved in the development and implementation of MRV systems, capacity building and developments of technical guidelines for emissions reduction in the industry and the development of policies to incentivize emissions reductions in the cement sector (IEA, 2012).

2.4.2.2 Support schemes for renewables

Ministerial Regulation No.12/2015 on the blending of biofuels is one of the most ambitious in the world, requiring companies holding a license to sell fuel to end users to achieve a 30% blending target of 30% by 2020 and 2025. The four sectors included are 1) transportation, 2) electricity, 3) industry and commercial and 4) micro-business, fisheries, agriculture and public services. The regulation sets more aggressive blending targets compared to last versions, **Regulations 32/2008** and **25/2013** (ICCT, 2016). Mainly the industries that use liquid fuels for heating will be impacted by this policy. Sectors such as cement generally use lower-grade fuels for heating, such as waste or coal. The same applies for the steel sector. This means that as a whole, the largest industries will not be affected so much by this regulation.

2.4.3 Comparison of recent developments and projections to benchmark

In the following section, the actionable indicators relevant to the industry sector will be assessed against the policies and projections in place in Indonesia. It should be noted that data on the industry sector in Indonesia is often limited, and is most detailed for the cement and steel sectors, since these are the most emissions intensive sectors. Significant emissions growth is also projected for both sectors under business-as-usual, 67% for cement and 90% for steel, between 2015 and 2030 (Dewi, 2015a).

*2.4.3.1 **Actionable indicator No.7:** All new installations in emissions-intensive sectors are low-carbon after 2020, maximise material efficiency*

Drawing from recent initiatives such as the Regulation Concerning CO_2 Emission Reductions in the Cement Industry and projects together with the Global Green Growth Institute, it appears that Indonesia's cement and steel sectors are putting in effort to enhance material efficiency and decarbonise their production processes. In the cement sector, process emissions have decreased significantly between 2000 and 2012. However, the steps made are likely insufficient for the sectors to be low-carbon after 2020.

In 2009, a study by the Indonesia Ministry of Finance, National Council on Climate Change of the Republic of Indonesia and the World Bank concluded that the cement sector is a high priority sector in terms of emissions reduction, economic contribution, and energy efficiency (Indonesian Ministry of Finance, 2009). The cement industry was facing above average inefficiencies but has a high incentive to cut energy costs due to low margins. The steel industry faces similar issues and requires financial incentives to reach the required emission targets. For comparison, the pulp industry is very profitable and competitive internationally and was not deemed to need fiscal or financial incentives to achieve emissions reduction targets (ibid.).

Total emissions from the cement sector are not reported, although annual process emissions have increased from 25 to 36 $MtCO_2$ between 2000 and 2012, a 44% increase. Given that cement production increased by 88% over the same period we can conclude that overall process emissions intensity has decreased. Indonesia's **Regulation Concerning CO_2 Emission Reductions in the Cement Industry** aims to take this further and reduce the emissions intensity of cement production. However, conflicting signals are being given simultaneously, since the Government recently established a domestic market obligation (DMO) to prioritize coal supply for, among others, cement producers (ADB, 2016).

In addition, the Global Green Growth Institute (GGGI) worked with the Indonesian Government in 2012 to assess the opportunity for accelerated investment in a range of green technologies in Indonesia. Predominantly, slag cement was proposed as a way to decarbonise the cement sector and in 2014, Krakatau Steel and PT Semen Indonesia signed a joint venture, which is engaged in the production of slag powder. Slag produced from Krakatau Steel will be used to lower the clinker content in SMI's cement production (GGGI, n.d.). This demonstrates that there is activity in Indonesia's most emissions-intensive sub-sectors to increase material efficiency and decarbonise their installations, but besides targets that have been set the broader strategies for emission reduction in the sub-sectors are missing.

2.4.4 Conclusion

In conclusion, specific policies to increase energy efficiency have been formulated for one of the high priority sectors, the cement sector. Industry sub-sector goals have been specified under the RAN-GRK and also suggest emission reduction options. At the same time, contradicting policies to stimulate the use of coal in industry have also been taken. Cross-sectoral cooperation is also showing, such as in the steel and cement sectors to implement best available technologies to reduce emissions and maximise material efficiency. However, a goal of having all new installations low-carbon in 2020 is with current policies not within reach for the steel and cement sectors in Indonesia.

2.5 Agriculture and forestry

The forestry and agriculture sector is of large economic interest for Indonesia, contributing to approximately 14% of the countries' GDP and employing around 33 million people, corresponding to 27% of the working population (The Global Economy, 2019). At the same time, Indonesia's LULUCF sector is by far the largest emitting sector, peaking at 1.6 $GtCO_2e$ in 2015 (66% of total GHG emissions), compared to 435 $MtCO_2e$ in 2000 (Minister of Environment and Forestry, 2018). For a large part, this increase is attributable to the rapid growth of palm oil plantations at a mean annual rate of 7% between 1990 and 2010 (Agus et al., 2013) and high emissions of peat fires (higher than previous years) that occurred in the 2015 El Nino year (Minister of Environment and Forestry, 2018). The palm oil plantations on average explain 55–59% of forest cover loss in the region, which in 2015 was still a loss of more than 700,000 hectares per year.

Compared to other sectors, emissions from the agriculture sector increased slower than in other sectors over the last decades, increasing by 13% compared to 2000 levels, reaching 113 $MtCO_2e$ in 2014 (Government of Indonesia, 2017). This makes this sector contribute to 6% of total GHG emissions. Primary emissions sources are methane emissions from rice cultivation, N_2O emissions from agricultural soils and methane emissions from enteric fermentation (Republic of Indonesia, 2015) .

Table 12: Table: Indonesia's progress on the most important steps in the LULUCF and commercial agriculture sectors to limit temperature increase to 1.5°C

Sector	1.5 °C-consistent benchmark	Projection(s) under current policies	Gap assessment (qualitative)	Policy rating
LULUCF	Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by 2025	• Overall land-use emissions in Indonesia are projected to increase from around 700 $MtCO_2e$ in 2010 to 2,300 $MtCO_2e$ in 2030 (Wijaya, Chrysolite, et al., 2017). • Projections of forest cover change that take into account REDD+ commitments, expect Indonesia's forest cover to increase by 23% in 2030 compared to 2015. • A large part of the oil palm and pulp industry has adopted a "no deforestation, no peat, no exploitation" policy. This should avoid new emissions from peat degradation. Monitoring of these commitments remains however challenging.	• As of 2015, still more than 700,000 hectares of forest loss took place in Indonesia, making it highly unlikely that net deforestation will be zero in 2020. • Recently established Peatland Restoration Agency aims to restore 2.4 million ha of degraded peatland to combat peat fires and emissions from peat decomposition. • Sub-national governments require more support for sustainable development and land-swapping schemes for peatlands under concession require revisions to better meet all stakeholders' needs.	Ambitious Plan
Commercial Agriculture	Keep emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research	• Depending on wealth improvements, diet changes and population growth livestock, product consumption will continue to increase.	• Indonesia's agriculture programmes have led to significant improvements in livestock efficiency. • Focus on land-based agriculture should increasingly shift towards increases in land productivity instead of opening new lands.	Ambitious Plan

2.5.1 Actionable benchmarks in agriculture and forestry

The Climate Action Tracker identified two short-term actionable benchmarks for the agriculture and forestry sector to limit warming to 1.5°C at a global level (Kuramochi et al., 2018):

- Emissions from forestry and other land use needs to be reduced to 95% below 2010 by 2030 and a stop of net deforestation to be achieved by 2025.
- Emissions from commercial agriculture in 2020 need to be kept at or below current levels with the simultaneous establishment and dissemination of regional best practice and a ramp up of research.

The following gap analysis compares historical and projected developments in the Indonesia LULUCF and commercial agriculture sectors to these global benchmarks without any further adjustment to allow for comparison between countries under analysis. Country specific circumstances will be addressed in the in-depth analysis on raising ambition in the following chapters. Please refer to the publication for more detailed explanation on each indicator.

2.5.2 Recent policy developments

Table 13 provides a comprehensive overview of the currently implemented and planned sectoral climate policies with the potential to affect GHG emissions directly.

Table 13: Overview of implemented climate change policies in the agriculture and forestry sector in Indonesia

<table>
<tr><th colspan="5">OVERVIEW OF EXISTING, PLANNED AND POTENTIAL CLIMATE CHANGE POLICIES FOR THE AGRICULTURE AND FORESTRY SECTORS IN INDONESIA</th></tr>
<tr><th>Changing Activity</th><th>Energy efficiency</th><th>Renewables</th><th>Nuclear or CCS or fuel switch</th><th>Non-energy</th></tr>
<tr><td colspan="5">Standards and support for sustainable agricultural practices and use of agricultural products
▪ Development credits for biofuels and plantation revitalisation (2007)
▪ Revitalization of Agriculture, Fisheries, and Forestry (2005)</td></tr>
<tr><td colspan="5">Incentives to reduce CO2 emissions from agriculture
▪ (none)</td></tr>
<tr><td colspan="5">Incentives to reduce CH4 emissions from agriculture
▪ Technical guideline for implementation of BATAMAS (Utilization of manure/urine of cattle and agricultural wastes for biogas) (2010 – 2014)</td></tr>
<tr><td colspan="5">Incentives to reduce N2O emissions from agriculture
▪ (none)</td></tr>
<tr><td colspan="5">Incentives to reduce deforestation or support for afforestation/reforestation
▪ Decree 62/2013 Regarding a Managing Agency for the Reduction of Emission (sic) from Deforestation and Degradation of Forest and Peat lands Indonesia (2013)
▪ Forest Law Enforcement National Strategy (FLENS) (2005)
▪ Forestry Law Act (1999)
▪ Government Regulation 24/2010 - The Use of Forests (2010)
▪ Government Regulation 76/2008 concerning forest rehabilitation and reclamation (2008)
▪ Legislative regulations on forest fires (1999)
▪ Law No. 6 of 2014 on Villages
▪ Regulation on Implementation of Demonstration Activities Reducing Carbon Emissions from Deforestation and Forest Degradation (2008)
▪ Ministerial Decision SK 13/Menhut-II/2009 (2009)
▪ Ministerial Regulation P. 12/Menhut- II/2009 on Forest Fire Control
▪ Ministry of Forestry Decree SK.323/Menhut-II/2011 (2011)
▪ Regulation on Implementation of Forest Carbon (2012)
▪ Regulation on the implementation of REDD activities (2009)
▪ Regulation No. 6/ HK.310/C/1/2013 on Technical Guidelines of SLPTT rice and maize (2013)
▪ Presidential Decree on the Structure of the Environment and Forestry Ministry (2015)
▪ Presidential Decree on Logging (2011)
▪ Presidential Decree No. 16/2015 on the Ministry of Environment and Forestry (2015)
▪ Presidential Instruction on combating illegal logging (2005)
▪ Presidential Instruction on Forest Moratorium (Development of REDD schemes) (2011)
▪ Ministry of Forestry Regulation No. 43/2013 (2013)
▪ Presidential Instruction on Forest Moratorium (2013)
▪ Procedures for Conversion of Allocation and Functions of Forest Areas (2010)
▪ REDD+ National Strategy (2009)
▪ Law against money laundering (incl. illegal logging) (2003)
▪ Presidential Regulation No. 71/2016 – moratorium to all new concessions on peatlands (2016)
▪ Presidential Decree No. 1/2016 – moratorium on peatland development (2016)</td></tr>
</table>

No policies currently exist and a similar policy gap exists in all other countries

No policies currently exist however Indonesia could adopt policies from other countries

Existing and planned policies for Indonesia

Given the importance of the agriculture and forestry sector to Indonesia's economy, many pieces of legislation are in place. However, since these are mostly decrees and decisions, they weigh less in terms of stringency compared to laws and government regulations (Pahlevi & Jong, 2018). Contradicting regulations are also in place, decreasing the effectiveness of these policies (The Asia Foundation, 2015). Besides, which entity has the mandate over forests is a complicated issue in Indonesia, where district governments and municipalities provide most governmental services. A few pieces of national legislation form the main body of forestry policy and is summarised below.

1. **Incentives to reduce deforestation or support for afforestation/reforestation**

The **Law No. 41 of 1999 on Forestry** requires rural districts to implement sustainable forest management practices. This is the first national law that includes some conservation-oriented policies and it places forest stands in the following categories: Conservation Forests, Protection Forests and Production Forests.

Ministerial Regulation P. 12/Menhut-II/2009 on Forest Fire Control constitutes a national programme aimed at the reduction of forest fire hotspots. The target was set at reducing the number of hotspot incidents by 67% compared to the incident average of 2005-2009. By 2014, the number of incidents was reduced by 87%.

Ministry of Forestry Decree SK.323/Menhut-II/2011 is a Ministerial Regulation that halts the issuance of any new licenses for harvesting in primary forest and peatland areas for the two consecutive years. This follows a USD 1 billion deal (in return for the moratorium) with Norway about the protection of Indonesia's forests and reducing its greenhouse gas emissions by 26% by 2020. However, the Regulation excludes concessions that were leased before May 2011 and does not protect secondary forest. In 2013 and 2015, the moratorium was extended.

Ministry of Forestry Regulation No. 43/2013 sets new Forest Area Boundaries, comprising 25,000 km^2 of newly classified forest area. This is aimed to reduce encroachments and illegal activities. This Regulation has also resulted in decreased rates of deforestation in these areas (Republic of Indonesia, 2015).

Law No. 6 of 2014 on Villages expands the authority of villages to manage their own assets and natural resources (Forest Legality Initiative, 2016). The Law has resulted in the reallocation of part of the national budget for forest management to villages to make local improvements.

Through the establishment of the Peatland Restoration Agency the Government has committed to the restoration of at least 2 million hectares of peatland. In addition, Indonesia is an UN-REDD partner country, meaning that they also have a National REDD+ Strategy in place since 2009. With this, the Indonesian government aims to "enhance the management of the forestry sector and supporting sectors, including plantations, agriculture and mining" (The REDD Desk, 2019).

2. **Standards and support for sustainable agricultural practices and use of agricultural products**

Regulation No. 6/ HK.310/C/1/2013 on Technical Guidelines of SLPTT rice and maize promotes the use of low-carbon farming practices through organic fertilizer, efficient water use, and minimum tillage of soils which will be applied between 2010–2014 in 2 million ha of agricultural area. So far it has avoided 30 $MtCO_2e$ in this period (Republic of Indonesia, 2015).

2.5.3 Comparison of recent developments and projections to benchmarks

2.5.3.1 ***Actionable indicator No.8:*** *Reduce emissions from forestry and other land use to 95% below 2010 by 2030, stop net deforestation by the 2020s*

Emissions from the Indonesian land-use, land-use change and forestry (LULUCF) have increased considerably between 2000 and 2012, from around 500 $MtCO_2e$ to 698 $MtCO_2e$ (+40%) (**Error! Reference source not found.**). It should be noted that emissions from the LUUCF sector are variable and approached 1.5 $GtCO_2$ in 2015 due to devastating peat fires in that year (Wijaya, Chrysolite, et al., 2017). To be in line with the 1.5°C-compatible benchmark (reduce emissions from the sector by 95% compared to 2010 levels), by 2030 LULUCF emissions should have been reduced to around 35 $MtCO_2e$. Given the current policy projections mentioned in the previous paragraph (2,300 $MtCO_2$ by 2030), this objective will be extremely challenging and substantial in the global context.

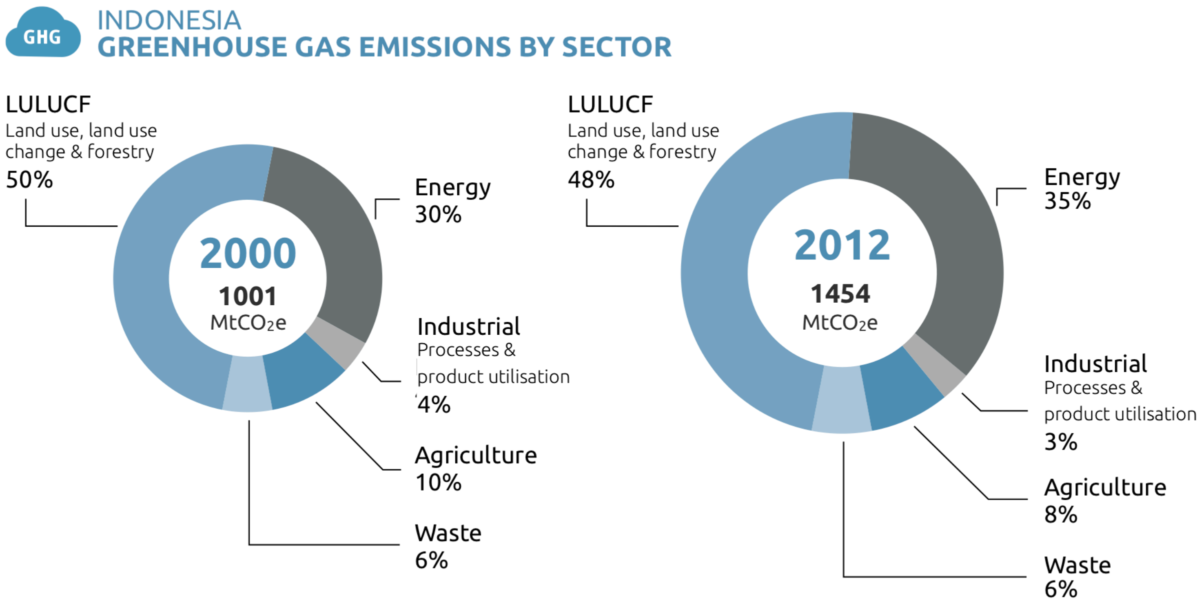


Figure 14: Development of GHG emissions in the Indonesian land-use sectors (Boer et al., 2016).

Commercial agriculture and resulting deforestation have oftentimes led to the drainage of organic soils, which leads to the oxidation of organic matter and subsequent greenhouse gas emissions. In addition, drained organic soils are much more susceptible to fire hazards. In Indonesia, awareness has strongly risen on peatland degradation and peat fires, which has created some political momentum to stop peatland fires (Harris, Minnemeyer, Sizer, Mann, & Payne, 2015). Already a result of this is that a large part of the oil palm and pulp industry has meanwhile adopted a voluntary "no deforestation, no peat, no exploitation" policy. The internationally operating palm oil firms also control the smallholders that supply the firms' mills, which would also limit new peatland drainage by smallholders. Monitoring of these commitments remains a challenge. More concretely, the Indonesian Government has set up the Peatland Restoration Agency (BRG), which has the aim of restoring 2.4 million ha of degraded peatland by 2020. In 2017, already 200,000 hectares were restored (see paragraph "Peat fires and peat drainage"). Given that a considerable share of LULUCF emissions is made up from peatland degradation and partly related peat fires, it can be stated that Indonesia is making progress towards achieving this benchmark.

To meet the future demand for palm oil, the Government of Indonesia has set a target to double the production of palm oil by 2020 compared to 2012, to 40 million tonnes of crude palm oil (CPO), and is expected to grow further to eight times this level in 2050 under business-as-usual

(Ditjenbun, 2015; GAPKI, 2014). It should be noted that this was before the large peat fires in 2015 and that there is currently a moratorium on new licenses for palm oil and mining concessions. It remains to be seen whether peatlands will be excluded from future expansion of palm oil plantations. Together with the establishment of various agencies that serve the purpose of disseminating information and conducting new research about Indonesia's forests and the development of sustainable forestry and agriculture guidelines, Indonesia is showing first steps towards achieving this benchmark, but it remains to be seen whether they can extend these achievements and demonstrate that the moratoria and peat restoration efforts have been effective.

Peat fires and peat drainage

Peat fires and peat drainage for agricultural purposes are a major contribution to overall emissions but is irrelevant to specify for a given year since emissions from peat fires are extremely variable. On average, emissions from peat fires and peat degradation contribute to around 62% of emissions from the LULUCF sector (Verchot et al., 2010).

However, Indonesia is making steps in tackling these issues. The coordinated efforts of the Indonesian Peatland Restoration Agency (BRG) have resulted in the construction of more than 16,000 canal blockings in 2016 and in 2017 around 200,000 hectares of peatland were restored, more than Europe has restored in its history. Canal blockings slowly result in the saturation of the peat soils with water, also called "rewetting". The governmental aim is to rewet 2.4 million hectares of drained peatland by 2020. In the light of what has been achieved in the world with regard to peat restoration, this 2020 aim is significant. Although 2017 can be called a success, it remains to be seen whether these successes can be replicated and whether sufficient monitoring and support for communities will be in place to ensure the peatlands stay rewetted.

Deforestation

Indonesia is facing difficulties in combating deforestation. Gross deforestation rates keep increasing, despite reduced numbers of concessions for oil palm and fibre, to which Ministry of Forestry Decree SK.323/Menhut-II/2011 contributed. The main reason for this is that around 55% of forest loss occurs inside legal concession areas, but still 45% occurs outside such legal areas where most expansion of activity occurred (Wijaya, Reidinar, Firmansyah, Samadhi, & Hamzah, 2017). As of 2015, still more than 700,000 hectares of forest loss took place in Indonesia, making it highly unlikely that net deforestation will be zero in 2020. However, in the longer-term progress could be significant. Projections of forest cover change that take into account REDD+ commitments, expect Indonesia's forest cover to increase by 23% in 2030 compared to 2015 (D'Annunzio, Sandker, Finegold, & Min, 2015), meaning that net deforestation could surpass zero well before 2030 if these commitments are met. The year 2017 was promising for Indonesia, since deforestation was reduced by around 60% compared to the year before (Hamzah, Juliane, Samadhi, & Wijaya, 2018). This was mainly due to the moratorium on deforestation on peatland and favourable climate conditions. If these successes are prolonged, achieving this benchmark could be feasible. However, it should be considered that by that time still many forest areas are under concession, and often more deforestation occurs than is reported due to illegal activity. This means that in terms of forest governance progress is required.

Other barriers

Factors that may hinder progress towards achieving this benchmark include the various contradicting regulations that are in place, which decrease the effectiveness of these policies. In addition, the lack of monitoring capabilities and resulting lenient enforcement of regulations could slow down progress (Seymour & Samadhi, 2018).

*2.5.3.2 **Actionable indicator No.9:** Keep commercial agriculture related emissions in 2020 at or below current levels, establish and disseminate regional best practice, ramp up research*

Population growth, increases in per capita consumption, and changes in diets, lead to the consumption of more livestock products and are the main drivers of agriculture product demand growth. Livestock population has grown from 928 million heads to 2,075 million heads. The emissions categories enteric fermentation and manure management were jointly linked to emissions of around 24 $MtCO_2e$ in 2000, which increased to around 31 $MtCO_2e$ in 2015 (Nugrahaeningtyas et al., 2018). Even though agriculture emissions intensity has decreased significantly, which shows an increase in livestock efficiency, the overall emissions increased. Together with the establishment of various agencies that serve the purpose of disseminating information and conducting new research about Indonesia's forests and the development of sustainable forestry and agriculture guidelines, Indonesia is showing first steps towards achieving this benchmark.

2.5.4 Conclusion

Although Indonesia is making progress in reducing its emissions from the LULUCF sector through, among others, efforts in reducing peat fires and peat degradation, a reduction of 95% below 2010 levels by 2030 does not seem within reach for the country. Current policy projections depict a considerable increase of LULUCF emissions towards 2030, which means that the 95% reduction in 2030 compared to 2010 will require substantially more effective policy.

Recent efforts in peatland restoration and reduction of deforestation as a result of the moratorium are promising, but it remains to be seen whether these achievements can be extended. Judging by the REDD commitments, and if the moratorium is extended towards the 2020s, the benchmark of having net zero deforestation before 2030 seems feasible.

In Indonesia awareness has strongly risen on agriculture-related peatland degradation and peat fires, and it is likely that a strong political pressure and will exists to stop these devastating events. Concerning knowledge development and best practices on sustainable agriculture, several policies and guidelines have been formulated, meaning that Indonesia is making some progress towards achieving this benchmark.

3 Selection of focus areas for analysis on scaling up climate action

The report prioritises three areas for in-depth analysis on scaling up climate action in Indonesia: the electricity supply sector, the passenger transport sector, and the forestry sector. This section explains the reasoning for looking further into these three areas of action considering the Indonesian national context and country-specific circumstances. It should be noted that the selection of focus areas in no way indicates that less mitigation action needs to happen in all remaining sectors. Relevant literature in the field and most recent emissions scenarios clearly indicate that all sectors need to maximise their efforts for Paris Agreement compatibility (Kuramochi et al., 2018). The selection of focus areas for scaling up climate action is based on following criteria combined with expert judgement by the authors.

i. **GHG emissions:** The relevance of the (sub-)sector in terms of historical and projected future GHG emissions
ii. **Existing gap**: The existing gap between currently existing and planned policies and 1.5°C compatible benchmark(s)
iii. **Potential for scaling up climate action:** The potential for enhancing climate action given local and global sectoral development (e.g. decreasing prices for RE technologies, CCS capacities, pending investment in infrastructure)
iv. **Priority in the national discourse:** Priority of the respective (sub-)sector in the national discourse or window of opportunity to enhance climate action due to recent social, political, or economic developments
v. **Overlaps with other sectors:** The (sub-)sector's overlap with other sectors relevant for long-term decarbonization (e.g. CO_2-neutral electricity sector in parallel to electrification trends in the transport or buildings sector)
vi. **Co-benefits potential:** Potential to realize co-benefits of scaling up climate action in a given country context (e.g. local job development through ambitious renewables deployment or reduction in urban air pollution due modal shifts away from combustion engines)

The following sections provide explanation for each sector selection, also considered the technical feasibility of the research for the sectors, e.g. lack of data availability might be a limiting factor.

3.1 Electricity supply sector

The focus on the electricity sector is justified by the significant share of emissions coming from the sector, combined with the important challenge of increased demand in the years to come. Electrification of the other sectors will further increase the impact of the sector's decarbonisation on the country's emissions.

- **GHG emissions:** with 12% of total GHG emissions in 2012 (incl. LULUCF), the power sector is one of Indonesia's larger emitter. Today, it represents about 25% of total CO_2 emissions and is projected to rise rapidly in the future (Government of Indonesia, 2017).
- **Existing gap:** based on Indonesia's electricity sector outlook (see RUPTL 2018), the country is headed for a fossil fuel lock-in due to a rapidly increasing electricity demand, which will largely be met with coal-fired power. There is no plan for coal phase-out in the medium to long term.
- **Potential for increasing ambition:** The potential for solar and geothermal is one of the largest in the world. The expected increase in electricity demand leaves a large potential for accelerated deployment of renewables. Indonesia's renewable plans predominantly

focus on hydro and geothermal, leaving significant room in particular for solar PV power but also wind, and geothermal to grow.

- **Overlaps with other sectors**: The flexibility of electricity makes it possible to replace other forms of energy in other sectors. It has an important role to play for the decarbonisation of other sectors such as transport and buildings.
- **Co-benefits potential:** increasing the share of renewables in the power sector and phasing out coal will lead to significant benefits by reducing air pollution as well as the costs of fossil fuel imports. Due to the distributed character of renewables it will also lead to job creation especially on remote island often affected by high levels of unemployment. Such co-benefits directly contribute to several of Indonesia's sustainable development goals, such as "promoting industry development, innovations and infrastructure sectors" (SDG 9), which is highlighted in the Indonesian Voluntary National Review (Republic of Indonesia, 2017), or "promoting access to affordable, reliable, sustainable and modern energy for all" (SDG 7).

3.2 Passenger road and rail transport

The focus on the transport sector justified by the significant share of emissions coming from the sector, the existing gap but also the potential for reduction in the short and longer term.

- **GHG emissions:** Transport emissions made up about 8% of total GHG emissions in 2012 and are projected to increase significantly due to increasing levels of welfare and therefore vehicle ownership.
- **Existing gap:** Increasing emissions from the transport sector take the country further away from the 1.5°C-compatible emissions pathway. The analysis shows a need to accelerate the path of sale of the zero-emissions cars and two wheelers and support modal shift to public transport in cities.
- **Potential for increasing ambition:** In the short term, biofuels have an important potential to decrease emission intensity if they are also accompanied by strong sustainability standards. Indonesia has announced a possibility of banning fossil fuel cars by 2040, but not yet how to get there.
- **Overlaps with other sectors**: Reducing emissions from the transport sector by replacing combustion engines by electric vehicles will require decarbonisation of the power sector.
- **Co-benefits potential:** Replacement of combustion cars by low/zero-carbon alternatives would also significantly reduce air pollution. Reduction in road traffic, especially trucks and motorbikes, would also reduce noise pollution and economic losses due to congestion.

3.3 Forestry sector

The focus on the forestry sector justified by the significant share of emissions it represents and the strategic role of the sector, even at international level

- **GHG emissions:** By far the largest emitting sector, with around half of total emissions, emitting close to 900 $MtCO_2$ on average in the five-year period between 2011-2015 and therefore of significant international importance.
- **Existing gap:** Although efforts are ramping up, current policy projections see an increasing trajectory of emissions towards 2030, which are supposed to go down by 95% compared to 2010 levels for a 1.5°C compatible pathway.
- **Potential for increasing ambition:** Indonesia already developed some strong regulation to tackle deforestation and peat fires, but implementation of the programs is still lacking.
- **Overlaps with other sectors**: Forestry sector has an important link with agriculture and all sectors where biofuels are expected to play a decarbonisation role.

- **Co-benefits potential:** Deforestation policy created, implemented, and enforced by local government can have a stimulating effect on the socioeconomic aspects of life of, for example, indigenous people living in or close to rainforests. Tackling deforestation is also key to preserve biodiversity or achieve biodiversity growth alongside ecosystem services positive outcomes as well as social positive outcomes.

4 Scenario analysis of scaling up climate action in Indonesia

This section presents detailed analysis of emission reduction potentials and selected co-benefits for three focus areas: **electricity supply, passenger road and train transport**, and the **forestry and other land-use sector.** The quantification of emission reduction potentials of enhanced climate action and the respective co-benefits covers three different scenario categories presented in the following section. This approach allows comparison of sectoral emission trajectories and potentials for achieving mitigation co-benefits with different sets of indicator values, informed by recent research in the field. The comparison further allows the identification of overlaps or gaps between Indonesia's sectoral emission trajectories and the sectoral transformations required for alignment with Paris Agreement targets on mitigation, other sector transformation case studies from international frontrunners, and alternate scenarios considering the specific national context. Where different analyses are available, some scenario categories present a range of indicator values, thus accounting for an upper and lower bound.

1.5°C Paris Agreement compatible

The **scenario category of '1.5°C Paris Agreement compatible benchmarks'** comprises of sectoral indicator values, which are in line with a 1.5°C compatible sectoral emission trajectory. Where available, these indicator values are country-specific benchmarks (e.g. country-specific RES indictor values for different points in time until 2050). Otherwise, this scenario category relies on indicator values representing global average levels or levels from countries/regions/cities with similar characteristics as default indicator values. The analysis in this scenario category enhances the general understanding about required sectoral transitions in the national context to be in line with the most ambitious end of the Paris Agreement's temperature target.

Applying best-in-class level(s)

The **scenario category 'Applying sectoral best-in-class level(s)'** identifies indicator values from international and regional frontrunner(s) on national climate action in the respective (sub-)sector. The absolute indicator level(s) or growth rate(s) from such reference cases are applied to historical national developments in the respective sector. These scenarios illustrate what impact the replication of sectoral transitions achieved by international frontrunners would imply in the respective national context. This approach might only partially account for potential differences in economic, political, and geographical circumstances between the international or regional front-runners and the countries under analysis.

National scenarios

The **scenario category 'National scenarios'** applies sectoral indicator levels obtained from research conducted by national research institutions or governmental agencies of the respective country under analysis. Such analysis might include least-cost scenarios, analysis on the general potentials for (sub-)sectoral transformation or long-term strategies/sectoral plans proposed by national governments or national non-state actors. This scenario category aims to illustrate the sectoral emissions abatement potentials suggested by national studies that consider the country-specific circumstances.

4.1 Electricity supply sector

4.1.1 Indonesian context for scaling up climate action in the electricity sector

Significant untapped potential of solar power

Estimated at 200–2,000 GW, solar PV has the highest resource potential in Indonesia (Deng et al., 2015a; IRENA, 2017b)**.** The geographical condition of Indonesia, with an average irradiation of approximately 4.8 kWh/m^2, is extremely suited for the development of solar energy. By 2017 Indonesia had an estimated installed solar capacity of 109 MWp (i.e. 0.1 GW)(Mulyana, 2016). Based on the most recent Electricity Supply Business Plan 2.1 GW of "other" generation technologies will be installed towards 2027, which can include solar PV but also biomass and diesel power. With this level of installed capacity, not even 1% of the total theoretical potential would be captured (Table 14).[12]

The development of solar power in Indonesia is facing many obstacles, such as an unstable regulatory framework that has seen various changes over the past decade, uncertainty around tariffs that are benchmarked against the regional generation cost, and difficulties surrounding permits and the purchasing of equipment abroad due to regulations on local content (Indonesian Ministry of Energy and Mineral Resources, 2018b). Deployment rates of solar PV could be increased substantially if investor confidence could be created through a stable regulatory framework for the stimulation of renewables.

Besides solar PV, Indonesia also has a significant potential of geothermal (holding 40% of global reserves), hydropower and waste biomass which can provide balancing power(Deng et al., 2015b). Wind power also ranks high, although offshore wind power (estimated potential of 52–1,000GW) is perceived to be too expensive at present due to sea depth. Hydro power has the additional issue that a significant share of this potential is in protected areas requiring resettlements (See Box 2). Around 8 GW could be developed by 2027 if no projects in protected areas were considered (MEMR, PLN, & JICA, 2011).

Table 14: Theoretical potential for renewable energy sources in Indonesia (EBTKE, 2016; IRENA, 2017a).

Source	Potential
Hydro	75 GW
Geothermal	30 GW
Biomass	33 GW
Solar	532 GW
Wind	61 GW
Ocean	18 GW

Increased electrification connecting remote rural areas of Indonesia

Off-grid solar PV contributes to the government's objective to deliver electricity to all citizens. Solar PV is expected to be deployed on a significant scale in three different forms, namely in utility-scale plants, on commercial and residential rooftops and as off-grid solution providing electricity to households that are currently not electrified. The off-grid solar potential is estimated to be 2.1 GW and will likely be fully exploited to increase energy access in remote locations (IRENA, 2017b).

12 The solar potential identified by IRENA takes into account supply-side constraints such as the availability of resources and land, however it does not into account constraints related to insufficient power demand or transmission networks.

Indonesia has worked hard on bringing electricity to people. Over the period 2010 to 2016, the national average electrification rate has increased from respectively 67% to 91%.[13] The government's objective is to reach an electrification rate of 97.4% by 2019 and 99.7% by 2025. The electrification rate across Indonesia varies significantly: ranging from electrification rates above 90% in densely and well-developed provinces on Java to electrification rates below 60% in remote located provinces in the east of Indonesia, such as Papua (i.e. 47.78%). The use of off-grid solar PV has been identified as key resource to provide electricity in these remote rural locations (IRENA, 2017b; PwC, 2017). As renewable energy prices fall, renewables are increasingly becoming the most cost-effective technology for remote areas. But the supports provided by the national electricity distribution company (PLN) to fossil-based projects to support electrification (e.g. PPAs for diesel and gas-powered projects in remote grids at rates above regional grid averages) could be counterproductive and lead to resistance to renewable energy projects even when renewables represent the most valuable technology in terms of costs and benefits (Bridle et al., 2018).

Contribution towards resource independency

The deployment of renewable energy strengthens Indonesia's resource independency while reducing emissions. Although Indonesia is a large producer of fossil fuels, imports of petroleum products increased due to Indonesia's declining oil production and growing domestic demand. Oil in Indonesia is mainly used for transportation fuels and small-scale power generation in remote areas. Domestic crude oil production decreased by 45% between 2010 and 2014 due to mature oil fields and limited investments to increase capacity (EIA, 2015; IRENA, 2017b). Subsequently, imports have been increasing, impacting the energy trade balance negatively.

Indonesia is also a large coal and gas producer but still largely driven by exports markets (Indonesia is Southeast Asia's biggest steam coal and gas supplier) and only a small share is used internally for the domestic market (IEA, 2017e). Instead of the additional use of domestic fossil resources, the Indonesian government can reduce both GHG emissions and the dependency on energy imports by stimulating the deployment of renewables (IRENA, 2017b). Since oil is primarily used for the transport sector, a shift towards the electrification of transport could also have a similar effect in reducing resource dependency.

Job benefits, local economic development, and reduction of air and water pollution

Renewable-energy related jobs could increase from around 0.1 million today to 1.3 million by 2030 (IRENA, 2017b)**.** At present, most of the renewable-energy related jobs in Indonesia are in the labour-intensive palm oil biodiesel industry. The number of jobs could increase significantly and be more diversified if investments take place in the development of renewable energy (IRENA, 2017b). Local employment is even more stimulated by the government's regulation on a minimum use of domestic goods and services for the development of electricity infrastructure, although this can at the same time also be a barrier to rapid deployment (PwC, 2017). The associated technology transfer in turn comes with additional positive effects to the economy (IRENA, 2017b). In general, renewable energy delivers more jobs per generated unit of power compared to fossil energy. At the same time, the jobs delivered by renewable energy projects are also more gender and skill-diverse, asking for various types of high-skilled and lower-skilled work-force (IRENA, 2018).

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13 Scepticism exists over the meaningfulness of this electrification indicator. Households can namely also have irregular access to electricity and face power blackouts, as is the case in many parts of Indonesia where the grid is not capable of dealing with peak power demand.

An ambitious transition towards a predominantly renewables-based electricity supply fosters the reduction of air and water pollution from coal combustion. In Indonesia a significant part of the air pollution and related impact on human health is caused by fossil fuel combustion. It is estimated that the existing coal-fired power fleet leads to around 6,500 premature deaths per year in Indonesia. Every additional 1 GW of coal-fired power capacity would lead to an additional 600 premature deaths per year (Boren, 2015). Besides air pollution, a study from Greenpeace showed that 45% of the rivers in South Kalimantan are at risk of toxic pollution due to coal concessions. This water pollution is already negatively affecting the local agriculture and aquaculture sector (Greenpeace, 2014).

4.1.2 Scenario analysis for scaling up climate action in the electricity sector

4.1.2.1 Identification of indicator levels

Table 15 provides a complete overview of indicator levels identified for the three different scenario categories. The indicator levels have been directly inputted into the PROSPECTS Indonesia scenario evaluation tool to conduct the emission pathway analysis for the Indonesian electricity supply sector. Data on the fuel mix that is defined in the scenario is also taken into account in PROSPECTS.

Table 15: Identification of indicator levels for analysis on scaling up climate action in the electricity supply sector

Indicator	Current Development Scenario (CDS)	National scenarios	Best-in-class scenarios	1.5°C Paris Agreement Compatible scenario
RE share	**11% in 2015**	-	-	-
	18% by 2030	**31-38% by 2030**	**24-37% by 2030**	**46-50% by 2030**
	Assumed constant from 2030	**44-56% by 2040**	**53-54% by 2040**	**70-88% by 2040**
		58-74% by 2050	**71-73% by 2050**	**78-99% by 2050**
	Based on PROSPECTS Indonesia tool developed by Climate Action Tracker (2018). Main source is APEC Outlook 2016.	*Based on 'Structural' and 'Renewables' scenarios from the Pathways to Deep Decarbonization series (Ucok WR Siagian et al., 2015)*	*Based on s-curve vRES update approach by Cornet at al. (2018) (developments in China) for upper bound and RE uptake values from literature (IEA, 2018) for lower bound*	*Based on 'Global 100% RE System' modelling results for Indonesia and Papua New Guinea by Ram et al. (2017) and Beyond 2°C Scenario from IEA ETP (2017) for the ASEAN region.*

1.5°C Paris Agreement compatible

The 1.5°C Paris Agreement compatible benchmarks represent sectoral indicator values for the renewable energy share (RES) in total electricity generation, which are in line with a 1.5°C compatible sectoral emission trajectory for the Indonesian electricity supply sector. The review of relevant literature in the field identifies values of **46-50% by 2030, 70-88% by 2040, and 78-99% by 2050**. The benchmark values have been derived from the following literature:

- **Upper bound of the RES indicator range**: The upper bound value is based on the 'Global 100% RE System' modelling results for Indonesia and Papua New Guinea by Ram et al. (2017). A similar exploration has also been performed by Günther et al. (2018), in their '100% Renewable Energy Scenario' for the Java-Bali power grid and both scenarios are characterised by significant deployment of solar PV, which in both studies makes up

between 85-90% of the fuel mix in the long term. Due to significant electrification of energy, power demand increases to around 950 TWh in 2050 in Ram et al. (2017).
The upper bound scenario is based on the following assumptions:

  - Coal generation is capped at current absolute level until 2025 and then follow absolute growth rate defined in lower bound scenario below (from IEA)
  - Non-Hydro renewable share follows a S-curve reaching 48% in 2030 and 98% in 2050. The mix of renewables technology is based on renewables deployment mix from Ram et al. (2017)
  - Hydro generation is capped at current absolute level (average of last 5 historical years)
  - The rest of the electricity generation mix is based on oil and gas generation, with a mix is based on National Scenario upper bound

The total share of renewables increases very rapidly from around 13% in 2017 to **50% by 2030**, **88% by 2040** and **99% by 2050.** This is considered as “Paris Agreement compatible” based on 1.5 °C-consistent benchmarks defined by CAT for renewable development and coal phase-out (Kuramochi et al., 2018) and also based on comparison of low-carbon shares from IEA’s Beyond 2°C Scenario for the ASEAN region (see below).

- **Lower bound of the RES indicator range**: The lower bound value is based on the share of renewables in IEA ETP’s Beyond 2°C Scenario (B2DS) for the ASEAN region. The B2DS provides a close analogue to a 1.5°C compatible pathway for the power sector by 2050 (see Box 4 below and (Climate Analytics, 2019)).
Since the initial fuel mix for the power sector in the ASEAN region differs from that of Indonesia, the two datasets were harmonized based on the following assumptions:

  - Fossil fuel generation is defined based on growth rate of absolute generation in B2DS
  - Nuclear and CCS generation is defined based on same share as B2DS (starting from 0)
  - Hydro generation is defined based on growth rate of absolute generation in B2DS
  - Non-hydro RES is defined based on remaining share, using the same mix as in B2DS

The total share of renewables in this scenario is **46% by 2030, 70% by 2040** and **78% by 2050**. It is important to note that this benchmark for RES alone is insufficient to reduce sector emissions in line with the Paris Agreement temperature goal if the remaining electricity generation stays GHG emission intensive (i.e. other than low-/zero-carbon). The IEA ETP scenario therefore has carbon capture and storage technologies applied to 10% of the fuel mix by 2040 and 17% in 2050, spread over coal (6%), gas (7%) and biomass (4%). It should be noted that the use of CCS as a mitigation option in many scenarios is assessed on the basis of capacity factors in the order of 80–90%, which is not likely to be achieved in combination with a high penetration of variable renewables. Due to the high marginal cost of electricity production, CCS plants would be pushed out of operation first (Brouwer, 2015). Nuclear energy is also considered in this scenario, which the Government of Indonesia is currently not considering as an option to meet their GHG reduction targets, unless the 2025 renewable energy targets are not met (IRENA, 2017a). Given that deployment of nuclear power as well as fossil fuel (coal and gas) with CCS is highly unlikely, based on cost competition with renewable energy, where costs are falling and expected to continue to fall, and given the large co-benefits that come with renewable energy, the share of renewable energy would be expected to be higher than the ones derived for this lower bound pathway, while maintaining the emissions profile consistent with the Paris Agreement 1.5°C temperature limit.
The share of decarbonised electricity in the lower bond scenario is 54% by 2030, 82% by 2040 and 99 % by 2050 and would have to be achieved with a corresponding increase of renewable energy capacity given nuclear and CCS are not seen as viable options . Coal is

phased out in 2040 in both scenarios, consistent with other analysis (Climate Analytics, 2019).

- Other scenarios considered for this analysis include the 73 IPCC 1.5°C compatible scenarios that assume no or low overshoot and are therefore consistent with the Paris Agreement long-term temperature goal (IIASA, 2018). Due to the regional aggregation in these models, the result is an average of the Asia region. Considering only those scenarios that meet the sustainability thresholds as defined in the IPCC Special Report on 1.5°C, such as the extent of BECCS used, the share of renewables in these 1.5°C compatible scenarios is 48% by 2030, 69% by 2040 and 74% by 2050 (IPCC, 2018).

Box 4: Considerations on consistency of the IEA Beyond 2°C Scenario with the Paris Agreement 1.5°C temperature limit

Box 4 IEA B2DS and 1.5°C compatibility

Whilst the IEA estimated that the B2DS pathway has a peak global warming of 1.75°C above pre-industrial with a 50% likelihood, both our own analysis and that of the IPCC confirm that it provides useful information on 1.5°C compatible pathways up to at least 2050.

We evaluated the IEA B2DS pathway applying the same climate model approach to warming levels as was used in the IPCC SR1.5 and earlier IPCC AR5, enabling a comparison of "like with like" with the IPCC 1.5°C compatible scenario set.

As IEA provides only energy-related CO_2 emissions land-use and non-CO_2 GHG emissions need to be estimated. In it is own estimation of the peak warming level the IEA assumed that non-CO_2 GHG would add about 0.35°C to the CO_2 only warming. For a full climate-model simulation one needs to assume pathways for non-CO_2 emissions and air pollutants. Rogelj et al (2015; 2018) showed that the key difference between 1.5°C compatible pathways and "likely below 2°C" scenarios is in CO_2 emissions, because the potential to reduce non-CO_2 emissions is seen as essentially the same as "likely below 2°C" scenarios. As non-CO_2 scenario information is available most extensively for "likely below 2°C" scenarios in the public database of IPCC SSP-RCP2.6 scenarios. Consequently, to evaluate the IEA B2Ds scenario we used the average of RCP2.6 scenarios (SSP2 representing middle-of-the-road socio-economic and technical developments) to characterize non-CO_2 emissions. In addition, we assumed CO_2 emissions from the land sector also follow the average of these scenarios, reaching largest amounts of annual removals of about -2 $GtCO_2$/yr around 2060, which we note is within the sustainable potential estimated by IPCC SR1.5 at around -3.6 $GtCO_2$/yr by 2050.

For energy related CO_2 emissions the IEA adopted a pre-defined assumption that there would not global negative CO_2 from the energy sector (IEA, 2017b), which is a feature of nearly all 1.5°C compatible pathways after 2050-2060. It is important to note that IEA B2DS energy sector CO_2 emissions reach net zero around 2060, supported by negative emissions through deployment of bioenergy with CCS, but are not allowed by assumption to lead to globally negative emissions. We extended the B2DS post 2060 with negative CO_2 from the energy sector comparable with 1.5°C compatible pathways.

To evaluate the global warming consequences of the B2DS scenario through 2100 we used the carbon-cycle/climate model MAGICC (Meinshausen, Raper, & Wigley, 2011) in the same configuration used for IPCC's Fifth Assessment Report (IPCC, 2014) and in the IPCC SR1.5.

The results of this evaluate show that after accounting for non-CO_2 GHGs as described above B2DS reaches a peak warming of 1.6°C above pre-industrial by 2060 and stays around that level afterwards. In contrast to 1.5°C compatible pathways in the IPCC SR1.5, warming does not drop to below 1.5°C after the peak.

Extending the B2DS energy related CO_2 emissions beyond 2060 to include negative CO_2 emissions comparable to those in 1.5°C compatible pathways leads to peak warming dropping below 1.5°C after the peak at 1.6°C.

It is clear that the IEA's predefined assumption of no net negative CO_2 from the energy sector leads to warming not reducing after the peak at 1.6°C and that if this is relaxed the B2DS is consistent with the IPCC compatible 1.5°C pathways.

The IPCC SR1.5 has also considered the utility of B2Ds for providing information on 1.5°C consistent pathways. In Chapter 2 of IPCC Special Report on 1.5°C, the B2DS scenario is shown to be consistent with 1.5°C pathways in terms of emissions up to 2060 (see section 2.4.3 and Figures 2.18, 2.19 and 2.20). While emissions intensity by 2050 in the power and industry sectors in the B2DS pathway are above those typical for 1.5°C pathways, B2DS emissions intensity is lower in the transport and buildings sectors. IPCC SR1.5 concludes that "… although its temperature rise in 2100 is below 1.75°C rather than below 1.5°C, this [B2DS] scenario can give information related to 1.5°C consistent overshoot pathway up to 2050." The IPCC did not conduct a like-for-like comparison of the full global warming consequences of the B2DS scenario, which as shown above results in a 1.6°C peak warming.

With these considerations, it is clear that both the energy-related CO_2 emissions in the B2DS scenario up to 2060, and its peak warming at 1.6°C around 2060 are comparable to low-overshoot 1.5°C scenarios. The B2DS scenario until 2060 is confirmed to be a suitable analogue to 1.5°C compatible pathways

Applying best-in-class levels

Applying best-in-class levels of international frontrunners in raising the renewable energy share in total electricity generation allows to understand how the Indonesian electricity sector might transform under similar developments. The application resulted in a RES indicator ranges of **24–37% by 2030**, **53–54% by 2040**, and **71–73% by 2050**. The range of indicator values have been derived as follows:

- **Upper bound of the RES indicator range**: The upper bound indicator values have been obtained by applying an s-curve shaped good practice trajectory for the uptake of variable renewable-based electricity generation (i.e., solar and wind) to Indonesia's status as of 2016. The s-curve has been fitted by applying China's historical growth in share of renewables generation between 2010 and 2016 (1.1% to 5.1%) and upper ceiling as defined by the Chinese Governments long-term target of 64% variable renewable electricity generation by 2050 (Energy Foundation, 2015). The methodological approach of fitting an s-curve is explained in a summary report by Cornet at al. (Cornet et al., 2018). The results for Indonesia with a share of variable renewables of 0.1% in 2016 are **8% by 2030**, **34% by 2040**, and **59% by 2050**. This share only includes variable renewable energy sources, i.e. renewable electricity generation based on solar and wind. The s-curve based approach to apply best-in-class levels narrowly focuses on variable renewables while not modelling the uptake of other low-carbon electricity generation technologies. For the uptake of other low-carbon technologies the same assumption as in the lower-bound scenario was applied, using a fixed percentage annual increase. The total share of renewables in this scenario is **24% by 2030**, **53% by 2040**, and **73% by 2050**.
- **Lower bound of the RES indicator range**: The lower bound values represent a linear increase of 1.5 %-points per year in Indonesia's share of renewable-based electricity generation. The annual increase in percentage points is informed by average growth rates of renewable energy in Germany after the implementation of ambitious renewables support policies (IEA, 2018b). The results for Indonesia with a share of renewable-based electricity generation of 12% in 2017 are **37% by 2030**, **54% by 2040**, and **71% by 2050**. This linear approach faces the limitation that no dynamic uptake in the renewable energy can be incorporated, especially when reaching the natural threshold of 100% in total generation. In both scenarios the development of non-renewable sources was based on the lower bound national scenario.
-

National scenarios

Recently published modelling results by Indonesian research institutions and intergovernmental bodies like the Indonesian CREP-ITB inform the selection of RES indicator value ranges for national scenarios in the Indonesian electricity sector. The RES indicator ranges are **31–38% by 2030, 44–56% by 2040, and 58–74% by 2050**. The range of indicator values have been informed by following modelling results:

- **Upper bound of RES indicator range**: The upper bound values are informed by the 'Renewables' scenario from the *Pathways to Deep Decarbonization* series for Indonesia, written by the Center for Research on Energy Policy - Institut Teknologi Bandung (CREP-ITB) and the Centre for Climate Risk and Opportunity Management in Southeast Asia Pacific (CCROM - SEAP), among others (Siagian et al., 2015). Due to the projected electrification of end-use, electricity demand increases dramatically in this scenario, from 165 TWh in 2010 to about 900–1000 TWh in 2050. Emission intensity of power decreases from 871 gCO_2/kWh in 2010 to 51 gCO_2/kWh in 2050, i.e. a 94% reduction in emission intensity. The modelling exercise under the 'Renewables' scenario yields a RES share of **38% by 2030, 56% by 2040** and **74% by 2050.**
- **Lower bound of RES indicator range**: The lower bound indicator values are based on the 'Structural' scenario, also from *Pathways to Deep Decarbonization* series (Ucok WR Siagian et al., 2015). This scenario is characterised by a larger focus on the demand-side and includes stronger energy efficiency improvements. This is also demonstrated by a lower final energy demand in 2050 of around 900 TWh. CCS is not deployed in this scenario, leading to a higher carbon intensity of 166 gCO_2/kWh in 2050. This modelled scenario gives an outcome for the RES indicator of **31% by 2030, 44% by 2040, and 58% by 2050**.

4.1.2.2 Quantification of emission levels with PROSPECTS

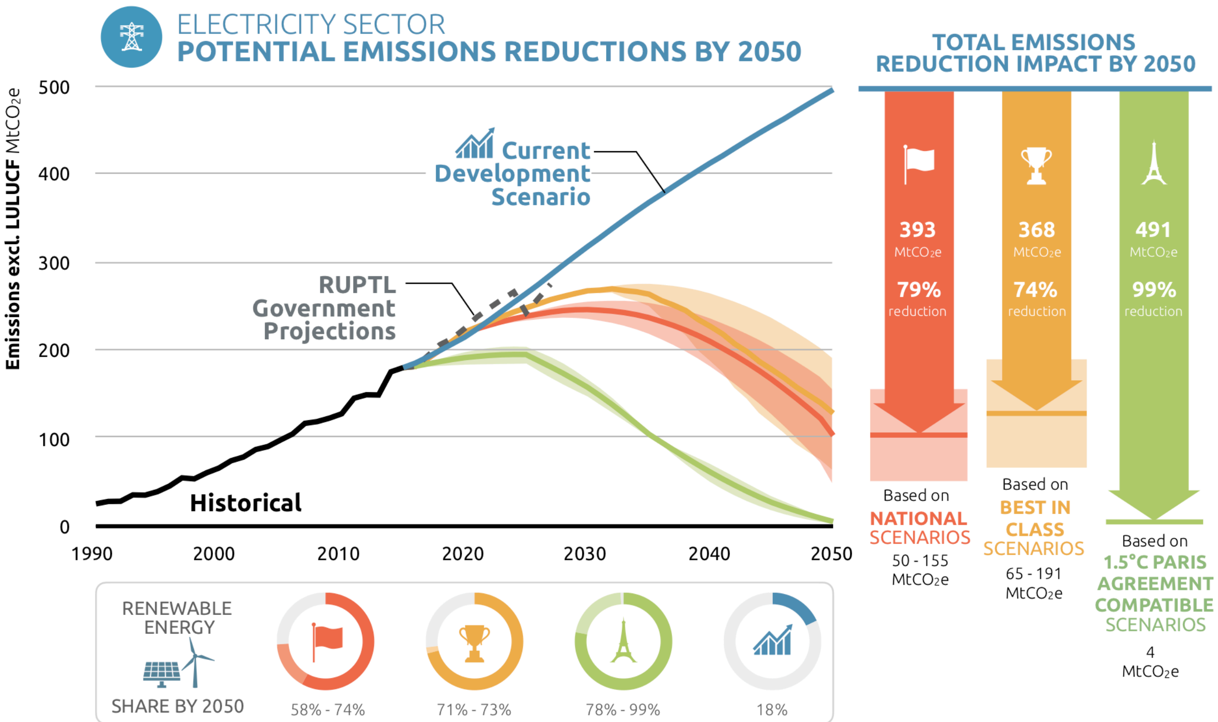


Figure 15: Overview of sectoral emission pathways under current policies and different levels of accelerated climate action in the Indonesian electricity supply. The forecasted electricity demand considers accelerated climate action in the Indonesian passenger transport sector. All sectoral projections towards 2050 done in the CAT PROSPECTS Indonesia scenario evaluation tool.

Figure 15 illustrates the emission ranges for emissions in the Indonesian electricity supply sector for various scenario definitions. The *current development scenario* (CDS) sees emissions more than double from 2020 to 2050 due to continued deployment of coal and gas-fired electricity to meet the rapidly rising electricity demand. The most recent Electricity Supply Business Plan (RUPTL 2018) sees levels of renewables in the power sector increase to 25% by 2025. If effectively implemented, such development could be a good start compared to 18% share in 2030 under CDS, but would likely not be sufficient to meet the conditional target of 41% emissions reduction below BAU specified in the RAN-GRK.

All pathways under accelerated climate action in the Indonesian electricity sector lead to emissions substantially lower than the current development scenario by 2050. The pathways vary in the level of emissions reached by 2050 and the distinct pathway trajectories:

- The upper bound (in terms of RE share) '**1.5°C Paris Agreement compatible' pathway** sees an immediate and steep reduction of emissions due to the ambitious s-curve based renewables deployment which substitutes emission intensive fuels for power generation. The sector reaches a level of 50% renewables by 2030 and 100% by 2050, with a fuel mix dominated by solar PV. The lower-bound (in terms of RE share) 1.5°C Paris Agreement compatible scenario initially reduces emissions faster and is also almost fully decarbonised by 2050 based on a larger share of hydro and the deployment of carbon capture and storage as well as nuclear technologies.
- The **'Applying best-in-class levels' pathways** curb emissions from the power sector by 24% to 30% below the *current development scenario* for the lower bound and higher bound scenario, respectively. Both the higher bound scenario and the lower bound scenario stabilize emissions around 2030, although emissions in the lower bound scenario, based on renewables development in China following an s-curve, more closely aligns with the current development scenario trend until 2030. If best-practice in renewables deployment were applied to the Indonesian power sector, emissions in 2050 would be around 78 – 129 $MtCO_2$.
- The **'National scenarios' pathway** falls in the roughly same order of emissions as the best-in-class levels pathway but with later peaking of emissions for the lower bound scenario, around 2035, meaning higher remaining emissions in 2050 for that scenario. With a renewables' share of 58–74%, and still having coal present in the national fuel mix, emissions in 2050 would be around between 54 and 163 $MtCO_2$.

Table 16: Key indicators describing the scenarios for GHG emissions from the electricity supply sector in Indonesia for the period between 2015–2050.

Scenario	Year of peaking	Maximum rate of reduction [absolute reductions in MtCO2e/yr]	Remaining emissions in 2050 [MtCO2e/yr]
Current Development Scenario (CDS)	No peaking	-	508
1.5°C Paris Agreement compatible	2025–2030	18.9	0
Applying best-in-class levels	2030–2035	10.2–17.7	42–152
National scenarios	2030–2035	11.0–13.6	50–155

The total electricity generation varies between different scenario categories due to changes in climate action in other sectors, e.g. increased electrification of passenger transport (see Figure 16). If required climate action in other sectors were also considered in this projection, such as in industry and buildings, projected electricity demand would change depending on fuel switches and energy efficiency measures per scenario. In ambitious climate action scenarios with lower electricity demand, less renewable capacity is required to achieve the same relative share of renewable electricity supply. The forecasted electricity generation continues to increase substantially in Indonesia until 2050 under all scenarios.

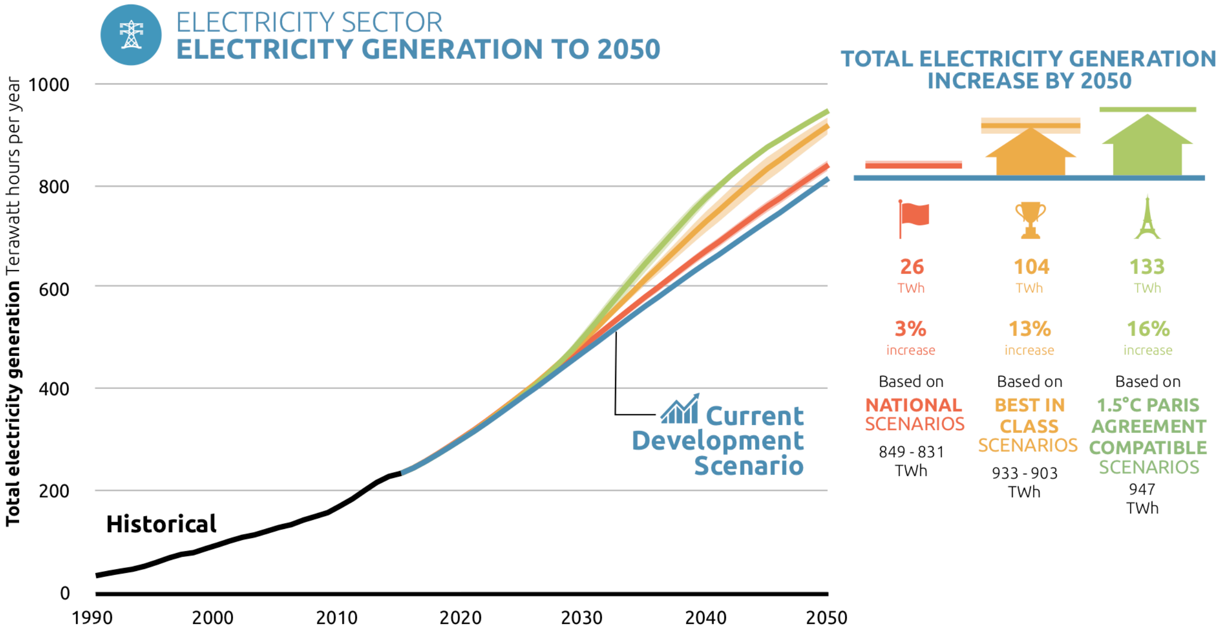


Figure 16: Total annual electricity generation (in TWh/y) in Indonesia under different scenario categories, considering the demand side effects from accelerated climate action from the passenger transport sector in the respective scenario categories. All sectoral projections towards 2050 done in the CAT PROSPECTS Indonesia scenario evaluation tool.

4.1.2.3 Quantification of employment impacts for different scenarios

Accelerated climate action in Indonesia can generate significant socio-economic co-benefits. If the transition focuses on an expansion of non-biomass renewables, it would have an important positive impact on the health of the overall population. As highlighted previously, existing coal-fired power plants in Indonesia cause an estimated 6,500 premature deaths every year (Boren, 2015). Such a transition would also provide an economic impulse due to the development of more innovative, low-carbon technologies and improve energy efficiency which would positively impact the economy's productivity (Siagian et al., 2015). Another benefit would be the improved energy security for some of the islands based on the large potential of domestic renewable energy sources (Indonesia's renewable energy potential is among the largest in the world).

This study focuses on the employment impact from renewable electricity deployment, only related to additional capacity construction and removals modelled in our scenarios between 2020 and 2030. It excludes the employment impacts related to existing generation and additional capacity scheduled before 2020. We assessed the impact of our scenarios on the creation of direct jobs in the electricity sector in Indonesia, differentiating by technology[14] and job type [15] for the years 2020 to 2030. We apply an employment factor-based approach suggested by Rutovitz et al. (2015) (see Appendix for a detailed description of the methodology, underlying assumptions and limitations).

14 The technologies considered comprise electricity generation from coal, natural gas, oil & diesel, nuclear, large-scale hydro, small-scale hydro, geothermal, biomass, onshore wind, solar photovoltaics (PV) and ocean/marine.

15 We estimate jobs in local manufacturing, construction & installation, operation & maintenance, fuel supply and nuclear decommissioning.

We find that the most ambitious scenario in terms of emissions reductions also yields the highest employment benefits over time, with an average potential of up to more than 290,000 additional direct jobs compared to current developments over the period 2020 to 2030 and The average additional employment impact varies between 30,000 to 40,000 jobs in the 'best-in-class' scenarios and between 28,000 and 60,000 in the national scenarios over 2020 and 2030 compared to the current development scenario.

For comparability of the results, we assume that all scenarios result in the same level of electricity demand and therefore the same level of additional power capacity needs. As described in the previous section, the most ambitious pathways include additional electrification measures that increase the overall electricity demand on the long term. If such increase was taken into account, the level of additional direct jobs from the most ambitious pathways would be even higher (e.g. an extra 30.000 jobs for the most ambitious '1.5°C Paris Agreement compatible' pathway).

The figures below illustrate the estimated total direct jobs (for additional capacity) in the electricity sector for renewables and for other power generation capacity averaged over the period 2020 to 2030 for each analysed scenario and also show the difference in the employment impact compared to the current development scenario.

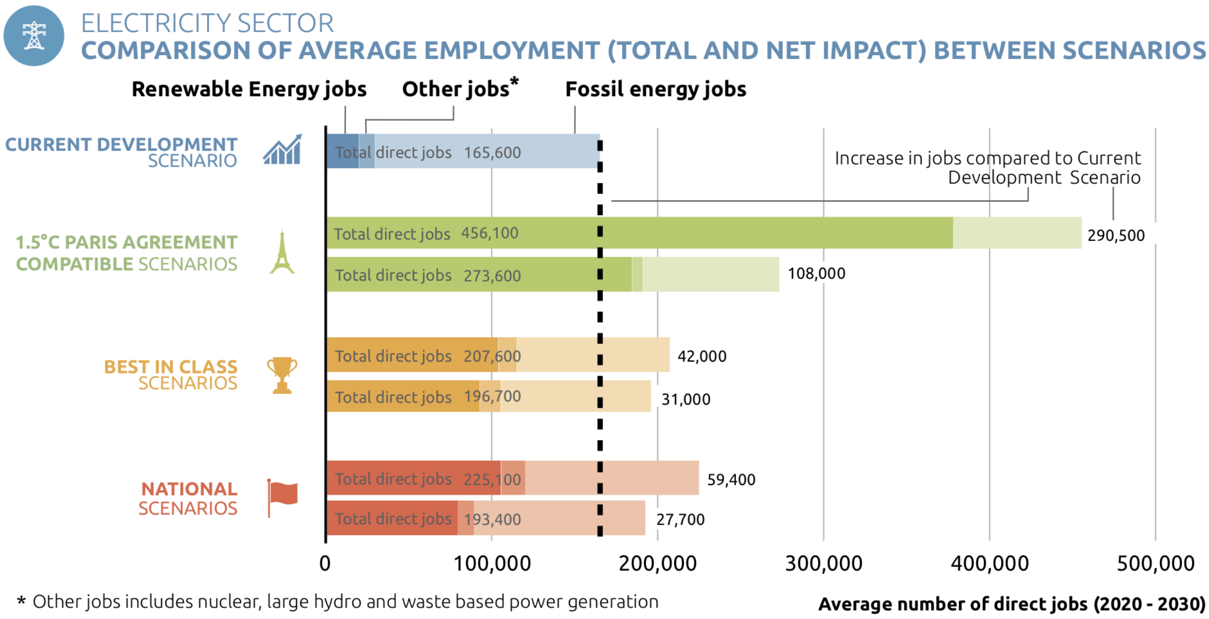


Figure 17: Average direct employment (FTE) impact between 2020 and 2030 in Indonesia per technology for different electricity generation scenarios. Shown is the estimated total direct jobs in the electricity sector averaged over the period 2020 to 2030, in the scenarios analysed in this study. The respective net direct employment impact compared to the reference scenario is also shown for each analysed scenario.

In terms of technologies, solar development is playing a central role in the future low-carbon electricity system of the most ambitious scenario, potentially representing on average more than 360,000 jobs over the period 2020 to 2030 in the most ambitious '1.5°C Paris Agreement compatible' pathway (as highlighted in the context section, IRENA predicted potentially up to more than 1 million additional direct and indirect jobs related renewable energy in 2030) (IRENA, 2016).

By contrast, the scenario assumes that coal capacity will remain capped at its current level until 2025 and will reduce rapidly afterwards. This is key to remain within the objective set by the Paris Agreement and avoid high risks of stranded coal assets. Although such rapid development could negatively impact the local coal supply related jobs (the mining sector), we also find that the loss will be compensated by new jobs created in the natural gas and biomass supply sectors in the short term and will be largely outweighed by additional new jobs in the building and operation of renewables.

This would give the domestic coal supply sector around 5 years to adapt and implement a "just transition" towards renewables. The potential impact on export coal related jobs (e.g. if the rest of the South-East Asia region would also move towards coal-phase outs) has not been included in the analysis.

Also, CCS-related jobs have not been included in the assessment due to lack of references to define a employment factor for such technology, potentially underestimating jobs in the lower bound '1.5°C Paris Agreement compatible' pathway.

In the most ambitious scenario, more than half of the jobs will be related to the construction and the installation of new power generation, mainly related to the large amount of additional renewable capacity to be installed in the decade to come. In the scenario, it is also expected that a large amount of additional long-term and high skilled jobs related to operation and maintenance of renewable plants will be generated.

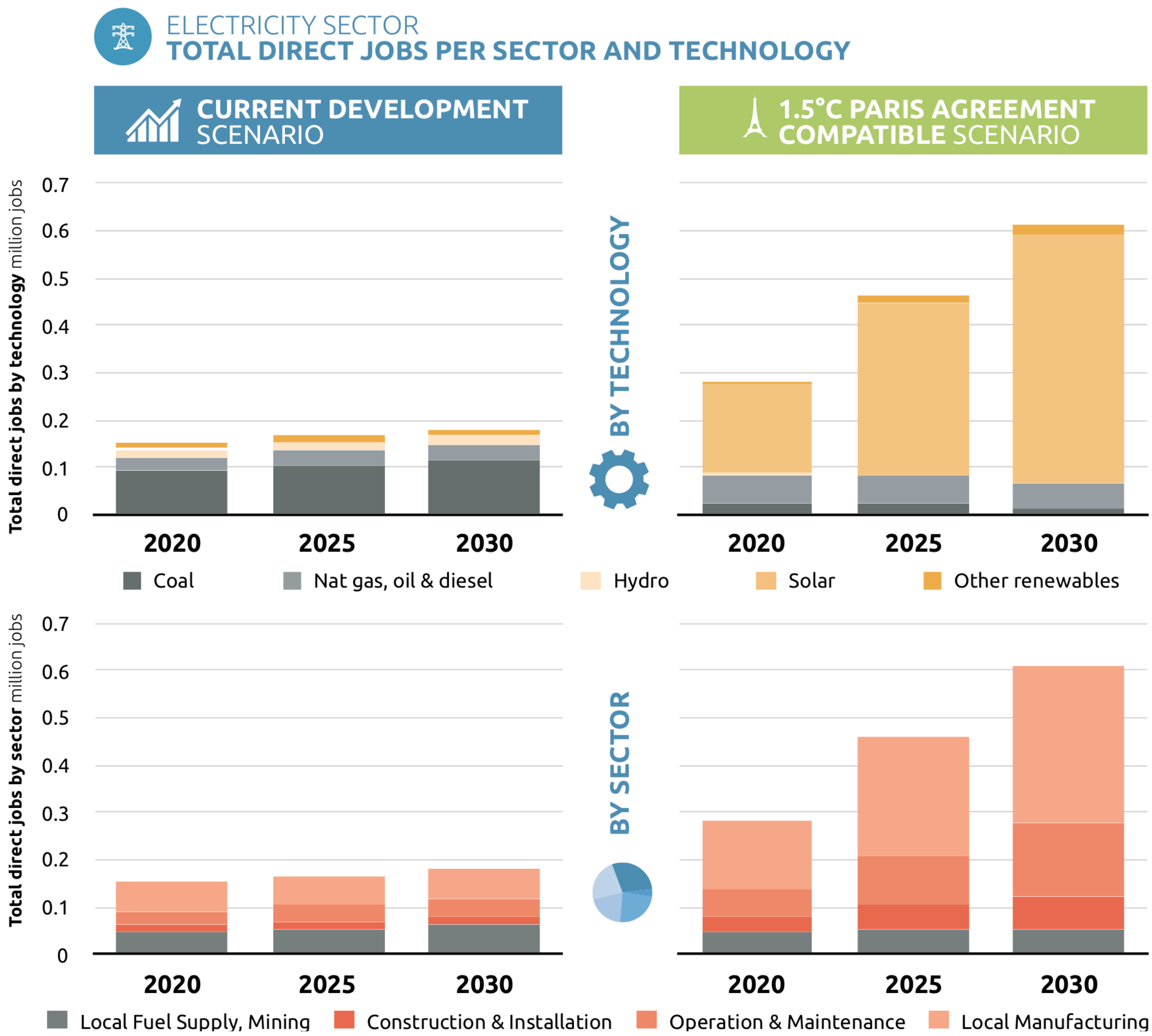


Figure 18: Total direct jobs per generation technology and total direct jobs per employment sector for the Current Development scenario (graphs on left) and the 1.5°C Paris Agreement compatible scenario (graphs on right) for the electricity supply sector. Note: 'other renewables' comprises of wind, biofuels, geothermal, marine and waste.

Our analysis does not include the expected positive impacts on local and high skilled jobs related to the development of electricity transport and distribution needs in the most ambitious scenarios.

Our estimates can be considered conservative as we only consider direct jobs related to the overall value chain of power generation, from fuel supply related jobs (including extraction and production of fossil fuels) to the jobs needed to operate and maintain the power plants (see Methodological Annex for more details). The analysis does not account for indirect jobs and induced jobs. Indirect jobs include jobs along the supply chain, such as the production of input material, e.g. producing concrete for the foundation of wind turbines. The literature suggests that indirect employment is of a similar order of magnitude as direct employment (see e.g. Ortega et al. (2015) for indirect employment in solar and wind). Induced employment impacts are economic impacts 'trickling down' to other parts of the economy due to wages spent that have been earned in created direct and indirect jobs. Jobs in energy efficiency, electricity transport and distribution, replacement of facilities and heat supply-related jobs have also not been taken into consideration in our analysis.

Box 5: Consideration of the impact of our scenarios on jobs in the coal sector in Indonesia

Box 5 Jobs in the coal sector in Indonesia

Indonesian coal production has risen dramatically over the last 10 to 15 years, and coal plays an important role in Indonesia's economy. In 2014, the mining industry represented the fourth-largest contributor to GDP (PwC, 2017) and coal represented nearly a third of primary energy supply (IRENA, 2017b). Indonesia is the world's largest steam coal exporter supplying half of Asia's steam coal imports (Oxford Institute for Energy Studies, 2017). The rapid and unstructured expansion has created a raft of problems, including deforestation, rampant corruption, illegal mining, overlapping land claims, and resource "sterilization" concerns (Stockholm Environment Institute, 2018).

Today, Indonesian coal extraction and production is still largely driven by coal exports; only a small share is used for the domestic market. However, coal demand by the Indonesian power market is expected to grow given the country's electrification plan of 2015 which foresees a large expansion of coal power. To support this, the government included in national energy policy to prioritise the sale of coal to the domestic market (Oxford Institute for Energy Studies, 2017).

Delivering adequate, affordable, and reliable energy to the local market has been a perennial challenge in Indonesia. Today 40 million Indonesians still do not have access to electricity (Oxford Institute for Energy Studies, 2017). Our analysis shows that prioritising renewable capacity developments to meet electrification needs would have a large positive impact on job creation and a limited impact on local coal supply related jobs in the medium term (compared to today). Scaling up the market for renewable energy technologies could also provide significant new opportunities to develop a local value chain. Specific initiatives could help to maximise localisation benefits, such as building local PV or geothermal technology specific knowledge capacity or involving local vehicle manufacturing base in the definition of EV infrastructure investments needs. This would also balance the negative impact on export related coal mining jobs in the coming decades due to a decrease in global coal demand expected under global decarbonisation scenarios.

4.2 Passenger road and train transport

4.2.1 Context for scaling up climate action in the transport sector in Indonesia

Indonesian passenger transport is facing many challenges

Indonesia has seen high growth in transport sector energy consumption over the past decade. Such rise in energy consumption in transport is a consequence of economic growth, relatively cheap oil fuel at subsidized prices, and the rapid rise in personal vehicle ownership, especially motorcycles, due to easy access to credit (Siagian et al., 2015). Indonesia transport sector will be facing two important trends in the future: high urbanisation rates and rapid motorization. Indonesia is transforming from a rural economy to an urban economy: its cities are growing more rapidly than other Asian cities and it is expected that 68% of the population will be living in cities by 2025 (The World Bank, 2016a). High urbanisation and rising income levels lead to rapid motorisation: vehicles numbers are predicted to double between 2010 and 2025 (GIZ, 2017).

These trends toward urbanisation and motorization are leading to the following challenges:

- **Deterioration of public transport:** The number of privately-owned vehicles is expected to increase rapidly, reducing the role of public transport and other modern mass transport systems. Indonesia's four-wheel market grew by double digits in the period 2003 till 2012, and is expected to continue to grow at a rate that even outperforms the growth in China (GIZ, 2017).
- **Traffic congestion:** Jakarta's traffic ranked the 12th worst in the world according to the INRIX Global Traffic Scorecard. This is a significant drop from the capital's 22th rank last year (INRIX, 2017).
- **The emissions of GHG's and other air pollutants:** Jakarta's poor air quality is for a large part caused by the city's high traffic environment. Monitoring data from the last decade show annual PM_{10} concentrations of 50 µg per m^3, being twice as high as the WHO limit of 20 µg per m^3 over a 24-hour period (ICCT, 2014).

Modal shift in transport systems is crucial to limit congestion impacts

One of the several important priorities Indonesia must tackle to develop a more sustainable transport system is creating an efficient, affordable and green public transport network in the main urban areas (The World Bank, 2018)**.** Take for instance the Greater Jakarta area, the number of private cars and motorcycles has grown rapidly because of unreliable public transport, low parking prices and subsidized fuel costs. To avoid a total gridlock, a Greater Jakarta inter-provincial transport agency has been established. Currently, Jakarta has two kinds of rapid transit systems: the TransJakarta Bus Rapid System (BRS) and Commuter Rail (KRL) (United Nations ESCAP, 2017). Jakarta will soon have its first mass rapid system (MTR) line. Together with measures to limit the number of cars in city centres, the promotion of mass transit, non-motorized transport and other smart growth measures aimed at reducing transport demand can significantly diminish the adverse effects of transportation. Java is also currently developing the very first long distance highspeed railway project of South-East Asia between Jakarta and Bandung and expects it completion by 2021 (The Jakarta Post, 2018).

Modal shift will play a key role to limit or even decrease the negative impact of congestion on environmental conditions and on the economic activity. According to a transportation study conducted by JICA in 2002–2004, the annual economic loss caused by traffic congestion in 2002 was estimated at IDR3 trillion (333 billion USD_{2004}) in vehicle operating cost and IDR2.5 trillion (278 billion USD_{2004}) in people's time loss. Since then the number of cars and motorcycles has still increased rapidly.

The role of electrification for urban passenger transport systems

As described in chapter 2, Indonesia has the ambition to further promote the use of electric vehicles through incentives, such as tax exemptions and the construction of a wide network of charging stations.

In addition, improved air quality has been an important argument for cities to implement EV support schemes (Hall, Moultak, & Lutsey, 2017). At least, electric vehicles have the potential to facilitate high shares of renewables in the national grid, by serving as a battery storage.

There are plenty of policies that can be applied on a local level and have proven successful in promoting electric vehicles, such as the provision of financial and behavioural incentives such as parking fee exemptions or access to bus lanes and the development of charging infrastructure (Hall et al., 2017; International Energy Agency, 2018). Furthermore, public procurement can increase the visibility of EV's and kick start a local market (Aber, 2016).

The key short-term role of fuel standards and biofuel for road transport systems

Indonesia can gain from existing international experience by implementing emission standards that have proven successful in metropolitan areas around the world. Cities around the world have approached the challenge of controlling air pollution from urban passenger transport with a range of technological and regulatory solutions. There are different strategies to consider: city actions around new vehicle emission standards and the clean-up of existing vehicles and infrastructure (ICCT, 2014).

Regarding new vehicle emission standards, Indonesian cities should establish stringent standards (i.e. Euro 4/IV and beyond) for vehicles sold in the city and discourage the purchase of diesel passenger cars through fiscal policies (ICCT, 2014).

Regarding the clean-up of existing vehicles and infrastructure, Indonesian cities should, amongst others, offer scrappage incentives to replace old vehicles by new Euro 4/IV compliant vehicles and establish low emissions zone in urban areas to ban high emission vehicles from certain areas (ICCT, 2014).

Indonesia has a large potential for the use of biodiesel, but sustainable use of land remains a major challenge. Increasing the domestic use of biodiesel is a pressing strategic issue for Indonesia. Indonesia is a net importer of petroleum products and a net exporter of palm oil. Replacing imported petroleum with domestic biodiesel is one of the of the strategies to reduce energy dependency (ICCT, 2016).

Indonesia's palm oil production has increased significantly over the past two decades, making Indonesia the word largest producer of palm oil. While many people continue to believe that palm oil biodiesel has a positive climate impact, the ICCT has previously shown that palm oil expansion in Indonesia is strongly linked to deforestation and peat draining, resulting in massive CO_2 emissions (ICCT, 2016).

It is key for Indonesia to explore lower carbon biofuel pathways. One option is the establishment of new palm oil plantations on degraded lands only. Degraded lands are defined as lands with very low biomass stocks and low levels of biodiversity (e.g. Imperata grasslands). Another option is the support of cellulosic biofuel production from sustainably available oil palm residues. Both options have the potential to greatly reduce GHG emissions compared to both the BAU palm oil biodiesel and fossil diesel (ICCT, 2016).

4.2.2 Scenario analysis for scaling up climate action in the passenger transport sector

4.2.2.1 Identification of indicator levels

Emissions reduction options in the Indonesian passenger road and rail transport sector

Among different options for emissions abatement in the passenger road and rail transport sector, this study considers modal shift, electrification and fuel intensity for in-depth analysis. For each indicator, a high ambition and low ambition indicator level is identified to illustrate the possible pathways.

- **Modal shift**: Shifting transport activity from modes with high specific emissions to modes with lower specific emissions can significantly reduce energy demand and average emissions per passenger kilometre. Indonesian cities are governed by privately owned cars with vast potential for substantial modal shifts to urban passenger transport systems.
- **Electrification**: Replacing vehicles with internal combustion engines with electric or plug-in hybrid vehicles reduces tailpipe emissions to zero or almost zero. Absolute emissions from electricity generation rise in turn due to higher power demand, unless electricity generation is fully decarbonised.
- **Fuel intensity**: Promoting the implementation of stricter fuel intensity standards to improve vehicle energy efficiency and reduce GHG emissions.

Table 17 overviews the analysis results for scaling up climate action in the urban passenger transport sector in Indonesia. The table below presents the value ranges for the sector-specific indicators values for each of the three scenario categories that have been implemented in the PROSPECTS Indonesia scenario evaluation tool to quantify emission trajectories.

Table 17: Outcome overview of analysis on scaling up climate action in road and rail passenger transport sector for Indonesia

Indicator	Current Development Scenario (CDS)	National scenarios	Best-in-class scenarios	1.5°C Paris Agreement Compatible scenario
Share of public transport **(% of bus and train in total road and rail passenger transport activity)**	**17 % in 2015** **17% in 2030** **13% in 2050**	**26-30% by 2030** **39% - 52% by 2050**	**28-33% by 2030** **45-58% by 2050**	**Same as BiC** No Paris Agreement compatible benchmark set at this level
	Based on PROSPECTS Indonesia tool developed by Climate Action Tracker (2018). Main reference is IEA Mobility Model.	*Based on 'Structural' scenario from the Pathways to Deep Decarbonization series (Ucok WR Siagian et al., 2015) for higher bound and "study for JABODETABEK region public transportation policy implementation* (Ministry of Transportation-Indonesia, 2012) *for lower bound*	*Based on High Shift Scenario for Other-Asia region in 2050* (ITDP, 2014) *for higher bound and on South-Korea public transport share achieved in 2015 (IEA, 2017) for lower bound*	*N/A*
Electric vehicle development **(EVs share in total fleet for cars, buses & 2W)**	**1% in 2030** **5% in 2050** **(cars)** **0% in 2030** **4% in 2050** **(buses)** **3% in 2030** **35% in 2050** **(2W)**	**9-18% by 2030** **20%-40% by 2050** **(cars)** **2-5% by 2030** **5% - 10% by 2050** **(buses)** **Same as CDS** **(2W)**	**17-18% by 2030** **58-89% by 2050** **(cars)** **24-31% by 2030** **60-92% by 2050** **(buses)** **20-21% by 2030** **60-89% in 2050** **(2W)**	**15-32% by 2030** **100% by 2050** **(cars)** **20-44% by 2030** **100% by 2050** **(buses)** **16-37% by 2030** **100% in 2050** **(2W)**
	Based on PROSPECTS Indonesia tool developed by Climate Action Tracker (2018). Main reference is IEA Mobility Model.	*Based on 'Structural' and 'Renewable' scenarios from the Pathways to Deep Decarbonization series* (Siagian et al., 2015)*for higher and lower bound respectively.*	*Based on a S-Curve developed from EVs development in new sales in Norway* (NewClimate Institute, 2018) *(with 90% sailing) for higher bound and on 'good practice' scenario for the rest of the world (10% in 2020 linearly extrapolated) developed by* (Fekete et al., 2015) *for the lower bound.*	*Based on CAT Benchmarks EVs share in new sales for World = 100% by 2035 to 2040* (Climate Action Tracker, 2019).
Fuel economy **(fuel intensity improvement for new non-electrified LDVs)**	**0%**	No ambitious and comprehensive national scenario available	**4.1% per year up to 2030** Assumed constant from 2030	**Same as BiC** No Paris Agreement compatible benchmark set at this level
	Based on PROSPECTS Indonesia tool developed by Climate Action Tracker (2018). Assumed constant.	*N/A*	*Based on average annual fuel consumption economy achieved in China between 2005 and 2014 (CAGR) as defined by ICCT* (Zifei & Bandivadekar, 2017)	*N/A*

1.5°C Paris Agreement compatible

To be in line with a 1.5°C compatible pathway, passenger transport-related emissions must decrease to almost zero around mid-century (Kuramochi et al., 2018). Accordingly, all personal vehicles on the road must be low-carbon by that time, requiring the last fossil fuel car to be sold by 2035 (Kuramochi et al., 2018). Recent research also highlights the importance of modal shifts in transport to achieve the GHG emissions reductions required to meet the Paris Agreement temperature target (Gota, Huizenga, Peet, Medimorec, & Bakker, 2018). Development of public transport would also reduce overall energy intensity of the transport demand and facilitate the electrification of the entire sector.

Additionally, the extensive reduction of emission intensity of new, non-electric cars is an important intermediate measure until the full electrification of the passenger transport sector is achieved by mid-century. To achieve lower emission intensity, both emission standards and biofuel blending will play role to achieve a clean transport sector more rapidly.

For modal shift, emission intensity and biofuel blending we apply the targets as identified in best-in-class scenario in the 1.5°C compatible scenario, since Paris compatible benchmarks are lacking.

- **1.5°C Paris Agreement compatible benchmarks – High ambition:**
  - **Modal shift**: As no 1.5°C Paris Agreement compatible benchmark is available for modal shift indicator, this scenario uses the higher ambitious end of the benchmark defined in 'Applying best-in-class level(s)' scenario: **58% of public transport** (bus and train) is used as a target share by 2050 based on the "High Shift Scenario" for other-Asia region. The increase is interpolated linearly.
  - **Electrification**: For all road transport modes (personal vehicles, bus, train and 2 wheelers), the **share of EVs in new sales** is modelled with an s-curve that **reaches 100% in 2035** based on the global CAT 1.5°C benchmarks for phase out year of fossil fuel vehicles in new passenger transport. With a lifetime for personal vehicles assumed to be 15-years, the new sales translate into shares of the total fleet via a stock turnover model. For buses, the lifetime is assumed to be 12 years, while it is set to 10 years for 2 wheelers. This leads to an indicator level of **32% electric cars in total stock by 2030 and 100% by 2050** (see table for bus and 2 wheelers).
  - **Emission intensity:** As no 1.5°C Paris Agreement compatible benchmark is available for emission intensity indicator, this scenario uses the higher ambitious end of the benchmark defined in 'Applying best-in-class level(s)' scenario: 4.1% emissions intensity reduction up to 2030 based on average annual fuel consumption economy achieved in China between 2005 and 2014 (CAGR) as defined by ICCT (Zifei & Bandivadekar, 2017). Such standards are comparable to 2°C compatible scenarios. Used in combination with existing stringent Indonesian policy to introduce a high share of biofuels in the transport sector (23% in 2020 vs. 8% in 2015), this type of development would likely be compatible with a 1.5°C compatible pathway for the transport sector. The emission intensity is assumed constant after 2030 as policy focus is shifting towards the uptake of electric vehicles and away from increasing the share of biofuels and making combustion engines more fuel-efficient.

- **1.5°C Paris Agreement compatible benchmarks – Low ambition:**
  - **Modal shift:** Similar to the higher ambitious scenario above, this scenario uses the lower ambitious end of the benchmark defined in 'Applying best-in-class level(s)' scenario: **45% of public transport** (bus and train) is used as a target share by 2050 based on the share achieved by South-Korea. Shares between now and 2050 are interpolated linearly.

- **Electrification**: For all road transport modes (personal vehicles, bus, train and 2 wheelers), the **share of EVs in new sales is modelled with an s-curve that reaches 100% in 2040** based on the Indonesia specific CAT 1.5°C benchmark for phase out year of fossil fuel vehicles in new passenger transport. Same lifetime assumptions are taken. This leads to an indicator level of **15% electric cars in total stock by 2030 and 100% by 2050** (see table for bus and 2 wheelers).
- **Emission intensity:** similar approach than high ambition scenario.

Applying best-in-class levels scenarios

The objective of the "best-in-class" scenarios is to assess the impact of sectoral transformations that have already occurred or that are expected to occur in specific comparable countries or regions. This would indicate that reaching similar level of changes could be considered as technically feasible for Indonesia, although disregarding potentially different political or socio-economic circumstances. For the three indicators assessed in this study, there are illustrative examples of countries or regions that have achieved or have a demonstrated potential to achieve an important level of transformation.

On increased share of public transport, South Korea (a recently developed economy) has achieved one of the highest shares of rail and bus in the modal split for passenger transport globally. In 2015, passenger train and bus trips represented almost 45% of the passenger-kilometers travelled on land (IEA, 2017d). Additionally, the ITDP has developed a technically feasible scenario (High Shift Scenario) for the development of public transport in the "other-Asia" region, reaching a share of 58% public transport in 2050 (ITDP, 2014).

On electric mobility development, Norway's support for electric cars serves as the best-in-class example. The global market share for electric vehicles (EVs) was only 0.8% in 2016 (IEA, 2017c). However, in Norway, EVs (including plug-in hybrids) accounted for nearly 30% of new cars in 2016 (IEA, 2018a). Additionally, the 2020 plan from the Indian government (India, 2012) is also considered as best-practice, with the target to reach 20% of EVs in new cars sales in 2030.

On emissions intensity of new vehicles, the EU sets one of the strictest fuel economy standard in the world. As the CO_2 emissions are proportional to the consumption of fuel, fuel economy regulations have the same impact on CO_2 emissions. In our scenario, the efficiency improvement is based on the extrapolation of proposed 2025 EU car standards to the region "rest of the World" up to 2030.

- **Applying best-in-class level(s) – High ambition**
  - **Modal shift**: **58% of public transport** (bus and train) is used as a target share by 2050 based on the "High Shift Scenario" for other-Asia region. The increase is interpolated linearly.
  - **Electrification**: **share of EVs in new vehicle sales** is following the historical growth rate observed for Norway between 2007 and 2017. The share of EVs in new sales is modelled with an s-curve based on the best practice case applied for Indonesia (NewClimate Institute, 2018). With a lifetime for personal vehicles assumed to be 15-years, the new sales translate into shares of the total fleet via a stock turnover model. This leads to an indicator level of **18% electric cars in total stock by 2030 and 89% by 2050** (see table for bus and 2 wheelers). For buses, lifetime is assumed to be 12 years, while it is set to 10 years for 2 wheelers.
  - **Emission intensity:** 4.1% emissions intensity reduction up to 2030 based on an average annual fuel consumption economy achieved in China between 2005 and 2014 (CAGR) as defined by ICCT (Zifei & Bandivadekar, 2017). The emission intensity is assumed constant after 2030 as, with the policy focus shifting on uptake of electric vehicles, we expect less development on combustion engines.

- **Applying best-in-class level(s) – Low ambition**
    - **Modal shift: 45% of public transport** (bus and train) is used as a target share by 2050 based on share achieved by South-Korea (taken as best-in-class reference with closest country context). The increase is interpolated linearly.
    - **Electrification**: **10% share of EVs in new vehicle sales** is applied as 2020 a target according to the 'good practice' policy scenario for the rest of the world developed by Fekete et al. (2015). We further extrapolate this target and assume a linear increase to 70% share of electric cars in new sales by 2050. With a lifetime for personal vehicles assumed to be 15-years, the new sales translate into shares of the total fleet via a stock turnover model. This leads to an indicator level of **17% electric cars in total stock by 2030 and 58% by 2050** (see table for bus and 2 wheelers)**.** For buses, lifetime is assumed to be 12 years, while it is set to 10 years for 2 wheelers.
    - **Emission intensity:** similar approach as high ambition scenario.

National scenarios

Energy consumption in the transport sector is expected to increase significantly with economic development and population growth. As described in Section 4.2.1, high urbanisation rates and rapid motorisation represent major challenges for the sector decarbonisation. Despite those challenges there are very limited national studies on potential low-carbon development pathways for the Indonesian transport sector. The national scenarios are mainly based on assumptions from the Deep Decarbonization Pathways Project (DDPP) that build upon a rigorous accounting of national circumstances. The Deep Decarbonization scenarios aim to define how Indonesia can decarbonise its energy systems while respecting the specifics of national political economy and the fulfilment of domestic development priorities (Siagian et al., 2015). We selected the "Structural' scenario as a national reference because it implies the lowest investment cost and lead to the same level of overall emissions reduction (corresponding to a decrease in terms of per capita emission, from 1.8 tons CO2 in 2010 to 1.3 tons CO2 in 2050). The scenario included transport sector assumptions on, for example, measures to improve equipment efficiency, switch of fuels to biofuel and natural gas in transport, the deployment of electric vehicles, and a shift in the predominant mode of transport from personal vehicles to mass transport.

Another key reference for the transport sector development in the country is the transportation policy study prepared for the Ministry of Transport in 2012 (JICA, 2012). Even though the study does focus on traffic congestion reduction (and not on decarbonisation of the sector per se), it includes some relatively ambitious transport related policy recommendations leading to lower carbon emissions and more specifically scenarios on the development of public transport for the studied region of Jakarta metropolitan area.

- **Scenarios – High ambition**
    - **Modal shift: 52% of public transport** (bus and train) is used as a target share by 2050 based on the 'Structural' scenario from the Pathways to Deep Decarbonization series (Siagian et al., 2015). The increase is interpolated linearly.
    - **Electrification**: **40% share of EVs in stock of cars and 10% share of EVs in stock of buses** are applied as 2050 targets based on the 'Structural' scenario from the Pathways to Deep Decarbonization series (Siagian et al., 2015). The increase is interpolated linearly.
    - **Emission intensity:** Assumed similar as Current Development Scenario based on existing ambitious biofuel blending policy in the transport sector (23% in 2020 vs 8% in 2015, and constant after 2020).

- **Scenarios – Low ambition**
    - **Modal shift: 39% of public transport** (bus and train) is used as a target share by 2050 based on a scenario for the Jakarta metropolitan area (JICA, 2012). The increase is interpolated linearly.
    - **Electrification**: **20% share of EVs in stock of cars and 5% share of EVs in stock of buses** are applied as 2050 targets based on 'Renewable' scenario from the Pathways to Deep Decarbonization series (Siagian et al., 2015). The increase is interpolated linearly.
    - **Emission intensity:** See high ambition scenario.

4.2.2.2 Quantification of emission levels with PROSPECTS

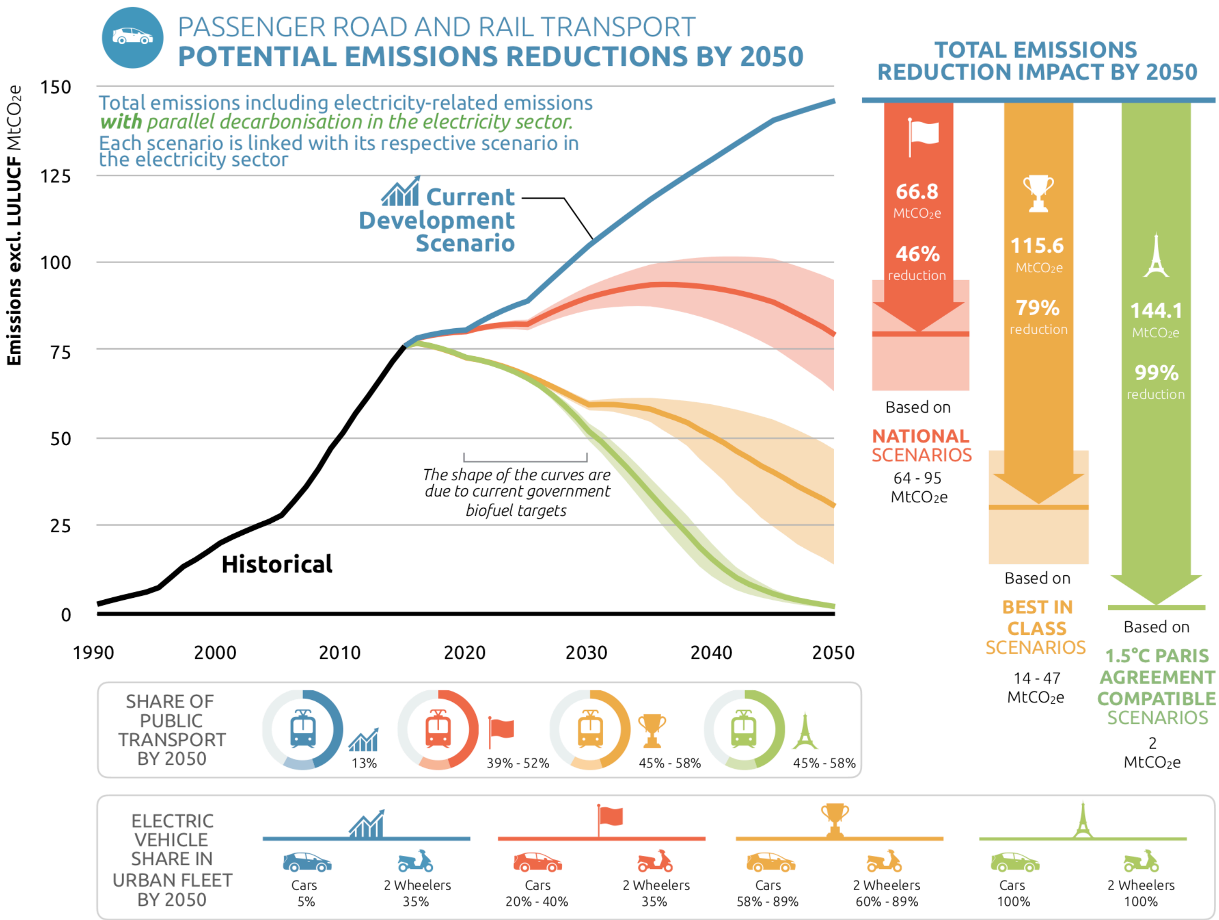


Figure 19: Overview of sectoral emission pathways under current policies and different levels of accelerated climate action in the Indonesian road and train transport sector (also including electricity related climate action in the respective scenarios). All sectoral projections towards 2050 done in the CAT PROSPECTS Indonesia scenario evaluation tool.

The figure illustrates the emission trajectories from the Indonesia's passenger road and rail transport for different analysed scenarios, while enhanced climate action in the passenger transport sector is further combined with decarbonisation of the electricity sector.

Under the current development scenario (CDS), emissions of the sector are expected to nearly double by 2050 compared to 2015 emissions to around 150 MtCO2e/yr. The CDS includes the already ambitious target biofuel blending set by the government by 2025, explaining the shape of the curve and the relative slowdown of emissions growth until 2025. But as from 2030, emissions are rising rapidly again due to expected growth of transport demand based on economic growth and accelerated motorisation. Biofuels could play a significant role in decarbonisation of the transport sector, but palm oil biofuel production is causing adverse effects as it has been a driver for the expansion of plantations into primary forest in Indonesia. Additional measures related to governance and sustainability certification are required for the biofuel mandate to have a positive environmental and climate impact.

The figure also demonstrates that applying mitigation measures on the demand side (such as strong electrification of the transport sector and modal shift combined with a simultaneous decarbonisation of the electricity sector) can achieve significant reduction of emissions of the sector by mid-century. All scaled-up climate action pathways imply much further emissions reductions in the passenger transport sector far beyond the current development scenario projections:

- The '**1.5°C Paris Agreement compatible'** pathway substantially reduces emissions and leads to the near complete decarbonisation of the passenger transport sector by mid-century (more than 95% reduction in 2050 compared to 2015 emissions). This is mainly driven by the strong electrification of the passenger vehicle fleet from 2030. The extension of the biofuel mandate up to 2030 (based on the assumption that sustainability measures highlighted above are taken), modal shift towards a higher share of public transport as well as emission intensity improvement of the remaining non-electric personal vehicles also play an important role in the short term to keep emissions level stable even with a growing travel demand (4% reduction in 2020 compared to 2015 emissions).
- The '**Applying best-in-class levels'** pathways also implies reduction of emissions until 2030 mainly based on the extension of the biofuel mandate up to 2030 (based on the assumption that sustainability measures highlighted above are taken) and fuel economy standards that could be applied (13% increase compared to 2015). The pathways include further reductions until 2050 (-25 to -43% compared to 2015) mainly based on electrification of the fleet based on current best practices in Norway or in the rest of the world. The 2050 emissions vary between 48 and 63 MtCO2e/a for the high and low ambition case, respectively, representing 67 to 75% reduction compared to CDS projection in 2050 (and around 40% reduction in 2030)
- The '**national scenarios'** pathways are less ambitious and see a growth of emissions compare to current level. Accelerated growth in the sector is only partially compensated by climate action measures and lead to emission increasing by up to 34% in 2030 and 70% in 2050 compared to 2015. In 2050, the scenarios reduce emissions to between 98 and 142 MtCO2e/a respectively, representing 25% to 50% reduction compared to CDS projection in 2050 (and around 10% in 2030).

To reduce emissions from the overall transport sector, additional policies would have to be introduced for maritime and aviation transport (which also play an important role in the fragmented island based country such as Indonesia) and for freight transport (refer to CAT freight memo (Climate Action Tracker, 2018)).

4.3 Forestry and other land-use

4.3.1 Evidence for scaling up climate action in the forestry and other land-use sector

Conservation of ecosystem services and biodiversity

Indonesia is home to one of the largest ecosystems on the planet which contains some of the world's highest levels of biodiversity (RAN, 2018). The large deforestation currently ongoing in Indonesia puts significant stress on the ecosystems and the services they deliver to society (BISE, 2011).[16] They include, among others, pollination, carbon sequestration, waste decomposition, buffer against extreme weather, and pest and disease control. Scaling up climate action will need to be focussed on the reduction or stopping of deforestation in the current fashion where large areas of primary forest are being cut down illegally, and so protect ecosystems from deteriorating.

Trees in tropical rainforest also absorb rainwater and in doing so regulate these water flows. Forest also filter and purify these water streams. Tree roots actively bind the soil surrounding them, thus preventing soil from being washed or blown away. In this manner forest conservation aids in the quality of the soil and ground water, and prevents soil erosion and landslides (Afanador et al., 2015).

The land-use sector is currently by far the largest emitter of CO_2 in Indonesia, emitting around 979 $MtCO_2e$ in 2014, with an average of 736 $MtCO_2e$ over the period 2004–2014 (Wijaya, Chrysolite, et al., 2017). Further deforestation, mostly due to the demand for arable land to develop palm oil plantations, will continue to eradicate carbon sinks throughout Indonesia and will lead to degraded soils and continued emissions that are significant in the global context. By stimulating efforts to reduce deforestation of Indonesia's tropical rainforest, carbon sinks can be preserved, and further efforts can be made to restore lost forest area. One obstacle is however the concessions that have been issued. Deforestation can legally continue within these areas, and for concessions on peatland land owners are stimulated to take part in a land swapping scheme.

Prevention of peat fires

Between June and October 2015 around 2.6 million hectares of land burned intentionally and unintentionally in Indonesia (Ministry of Environment and Forestry, 2015). The Global Fire Emissions Database (2016) estimates that a significant part of the fires was intentionally set on fire to clear land for palm oil plantations. Due to a set of factors, such as drought, bad monitoring, insufficient law enforcement and the influence of El Niño, fires spiralled out of control, burning far more land than initially intended. Every year during the dry season these fires reoccur, causing a hazard for health, climate, the economy and the environment.

A conservative estimate of the cost for Indonesia related to these fires is 16.1 billion USD, while the projected commercial benefits are around 8 billion USD. This financial gain is distributed over a small group of farmers and enterprises while the large masses suffer the economical and health-related burdens. Around one-third of all the land that was burned was categorized as peatland. All burning land releases CO_2 and other greenhouse gases such as CH_4, but this CO_2 is reabsorbed when nature grows back. This is not the case for peatland since these soils have thousands of years of carbon stored in them which cannot be easily restored (World Bank, 2016). Next to the emission of greenhouse gasses, the burning of dry peatland is dangerous; it burns rapidly, and it is difficult to extinguish. Burning peatland also creates haze due to the large

16 Ecosystem services are generally described as ''direct and indirect contributions of ecosystems to human wellbeing''.

quantities of aerosols. Next to being a significant health hazard, this haze hinders transport, tourism, trade, as well as education.

Although burning forest on peatland soil has been outlawed since 80s, legislation has so far not managed to significantly reduce peat fires in Indonesia. Governmental programmes that persuade land owners to stay away from burning their land, as well as programmes that support the protection, rewetting, restoration and management of peatland areas could contribute to reducing peat fires. Some certification standards already exist to steer away from fire use in palm oil plantations but so far this has not delivered the sought-after results (The World Bank, 2016b).

Job benefits, local economic development, and "just transition"

Deforestation policy created, implemented, and enforced by local government can have a stimulating effect on the socioeconomic aspects of life of, for example, indigenous people living in or close to rainforests. Numerous publications have researched the effect in Central America and claim it can strengthen land tenure rights of villages and tribes of indigenous people, which gives them more protection from illegal deforestation and offers economic potential for them in the sense of governmental purchase of off their land's products or allowances for the population living there (Ding et al., 2016).

Secondly, paying for ecosystem services (PES) are schemes with which is it possible to preserve biodiversity or achieve biodiversity growth alongside ecosystem services outcomes as well as social outcomes (Pagiola, Arcenas, & Platais, 2005). PES rest on the notion that the providers of ecosystem services are to be reimbursed or paid for their efforts by the ones which are benefitting from these services. In this case this means that farmers, farmer groups, or villages get financial compensation for planting trees, rehabilitating degraded forest land, or avoiding deforestation. In this manner PES has the potential to improve the supply of ecosystems services such as carbon sequestration, while offering financial income and stability for the rural or indigenous population. Currently around nine of these PES schemes are active in Indonesia and are already implemented, focussing on water and carbon ecosystem services (Suich et al., 2017). Expanding the reach of PES and increasing the total number of implemented projects could aid significantly in increasing the carbon sink, previously mentioned, while improving the supply of other ecosystem services and offering local economic development.

4.3.2 Scenario analysis for scaling up climate action in the forestry and other land-use sector

4.3.2.1 Identification of indicator levels

The table below overviews the analysis results for scaling up climate action in the forestry and other land-use sector in Indonesia. The table presents the value ranges for the sector-specific indicators values for each of the three scenario categories that have been implemented in the PROSPECTS Indonesia scenario evaluation tool to quantify emission trajectories.

Table 18: Identification of indicator levels for analysis on scaling up climate action in the forestry and other land-use sector

Indicator	Current Development Scenario (CDS)	National scenarios	Best-in-class scenarios	1.5°C Paris Agreement Compatible scenario
Deforestation reduction compared to 2010 levels **(associated emissions in that year)**	**Net emissions in that year** **(503 MtCO₂ by 2015)** **(294 MtCO₂ by 2030)** (stay constant after 2030)	-	-	-
		47% by 2030 **(217 $MtCO_2$)**	**81% by 2030** **(78 $MtCO_2$)**	**30% by 2030** **(284 $MtCO_2$)**
		(stay constant after 2030)	**95% by 2040** **(21 $MtCO_2$)**	**74% by 2040** **(104 $MtCO_2$)**
			99%% by 2050 **(6 $MtCO_2$)**	**81% by 2050** **(78 $MtCO_2$)**
		Based on Indonesian Government's 'Mitigation 2' scenario from Second National Communication (Indonesia MoE, 2010).	*Based on deforestation growth rates seen in literature (Brazil) (FAO, 2015).*	*Based on deforestation rates in the 1.5°C GLOBIOM model (global region)*(Roe et al., 2017).
Afforestation and reforestation **(associated emissions in that year)**		-	-	-
		15.2 Mha by 2030 **(-262 $MtCO_2$)**	**22.5 Mha by 2030** **(-388 $MtCO_2$)**	**25 Mha by 2030** **(-436 $MtCO_2$)**
		constant until 2050	**36.2 Mha by 2040** **(-625 $MtCO_2$)**	**35 Mha by 2040** **(-609 $MtCO_2$)**
			51.8 Mha by 2050 **(-894 $MtCO_2$)**	**45 Mha by 2050** **(-782 $MtCO_2$)**
	Based on WRI (Wijaya et al., 2017). Indicators not available for CDS. *Emissions are net deforestation emissions (i.e. deforestation + afforestation/reforestation)*	*Based on Indonesian Government's 'Mitigation 2' scenario from Second National Communication (Indonesia MoE, 2010).*	*Based on India's strong afforestation programme, in combination with tree survival rates observed in the US (India MoEF, 2009).*	*Deduced from afforestation emissions in the 1.5°C GLOBIOM model (global region) (Roe et al., 2017).*
Drained peatland restored (remaining emissions from peatland decomposition in that year)	**(224 $MtCO_2$ by 2015)**	-	-	-
	(277 $MtCO_2$ by 2030)	**2 Mha by 2030** **(120 $MtCO_2$)**	**2.8 Mha by 2030** **(89 $MtCO_2$)**	**4.5 Mha by 2030** **(0 $MtCO_2$)**
	(314 $MtCO_2$ by 2040)	(stay constant after 2030)	**4.5 Mha by 2040** **(0 $MtCO_2$)**	**4.5 Mha by 2040** **(0 $MtCO_2$)**
	(349 $MtCO_2$ by 2050)		**4.5 Mha by 2050** **(0 $MtCO_2$)**	**4.5 Mha by 2050** **(0 $MtCO_2$)**
	Based on WRI (Wijaya et al., 2017). Emissions related to peatland decomposition.	*Based on Indonesian Government's NDC scenario, which specifies 2 Mha of peatland restoration up to 2030* (Government of Indonesia, 2016).	*Based on peatland restoration achievements made by Indonesia over the year 2017* (Gewin, 2018).	*Based on extrapolated peatland restoration achievements made by Indonesia over the year 2017* (Gewin, 2018).

1.5°C Paris Agreement compatible benchmarks

The 1.5°C Paris Agreement compatible benchmarks represent sectoral indicator values for the level of net deforestation occurring and one for the emissions in other land-use categories, which are in line with a 1.5°C compatible sectoral emission trajectory for the Indonesian forestry and other land-use sectors. The review of relevant literature in the field (see table above) identifies a range of **30% by 2030, 74% by 2040** and **81% by 2050** for the decrease in deforestation compared to 2010 levels, **25 Mha by 2030, 35 Mha by 2040** and **45 Mha by 2050** for the area of afforested and reforested forest, and for the level of peatland restoration **4.5 Mha by 2030 and constant thereafter**. The benchmark values have been derived from the following literature:

- **Deforestation:** To know whether a certain pathway is 1.5°C consistent, it is important to test this in relation to other sectors. Integrated assessment models (IAMs) aim to simulate various socio-economic and biophysical models together to find cost-optimal pathways to achieve emission levels that are consistent with a 1.5°C pathway. For this indicator, values are based on a 1.5°C pathway from the GLOBIOM model. This pathway sees deforestation reduce by about 80% by 2040, compared to 2020 levels with minimal reductions afterwards. The chosen indicator levels from GLOBIOM yield a reduction in deforestation compared to 2010 levels of **30% by 2030, 74% by 2040** and **81% by 2050.**
- **Afforestation and reforestation:** These indicator values are also based on the GLOBIOM 1.5°C land-use pathway. Since specific afforestation levels for Indonesia are not provided, this was deduced from the global emissions trajectory using an emission factor of -17 tCO_2/ha/year (Griscom et al., 2017). For Indonesia, this would equate a level of afforested/reforested stock of **25 Mha by 2030, 35 Mha by 2040** and **45 Mha by 2050**. Given that the level of forest area in Indonesia is, depending on the definition of forest area, around 95 million ha, this is an ambitious level of afforestation/reforestation. However, given that the level of degraded forest in Indonesia lies around 40 million ha, in addition to around 25 million ha of degraded agricultural land these rates may be attained (Nawir Murniati & Rumboko, 2007). Competition with agricultural land may however become an issue.
- **Peatland restoration:** Peatland restoration or forest on peatland is generally not modelled by IAMs (Hall et al., 2017)(PBL, 2014). 1.5°C consistent indicator levels were not modelled by the GLOBIOM pathway used for deforestation and afforestation emissions, but the study stresses that peat fires should be addressed imminently and halted by 2020. Simultaneously, efforts to restore peatlands should stop emissions from peatland degradation by 2030. This leads to a substantial reduction of LULUCF emissions in Indonesia of 60% compared to the 2010–2015 average already by 2020. This is primarily due to stopping peat fires. To arrive at a 100% reduction of emissions from peatland degradation, restoration efforts would need to attain a rate of little over 0.3 Mha per year. This would lead to an area restored of **4.5 by 2030**, since this was the level of peatland assumed to be drained and deforested in 2010. To develop the emission pathways an emission factor of drained peatland in Indonesia was assumed to be 51 tCO_2/ha/year, whereas restored peatland was assumed to not regain its function as a carbon sink (Ministry of Environment and Forestry, 2015; Wilson et al., 2016).

Applying best-in-class levels

Applying best-in-class levels of international frontrunners in addressing deforestation and peatlands allows to understand how the Indonesian forestry and other land-use sector might transform under similar developments, although noting that Indonesia could well be in the position to perform better than these frontrunners. Historic data for Indonesia is applied until 2017, after which historic developments in Brazil and India are applied. The application resulted in indicator ranges of **81% by 2030, 95% by 2040 and 99% by 2050** for deforestation reduction compared to 2010 levels, **22.5 Mha by 2030, 36.2 Mha by 2040** and **51.8 Mha by 2050** for afforestation and reforestation and **2.8 Mha by 2030** and **4.5 Mha by 2039** for the area of restored peatland:

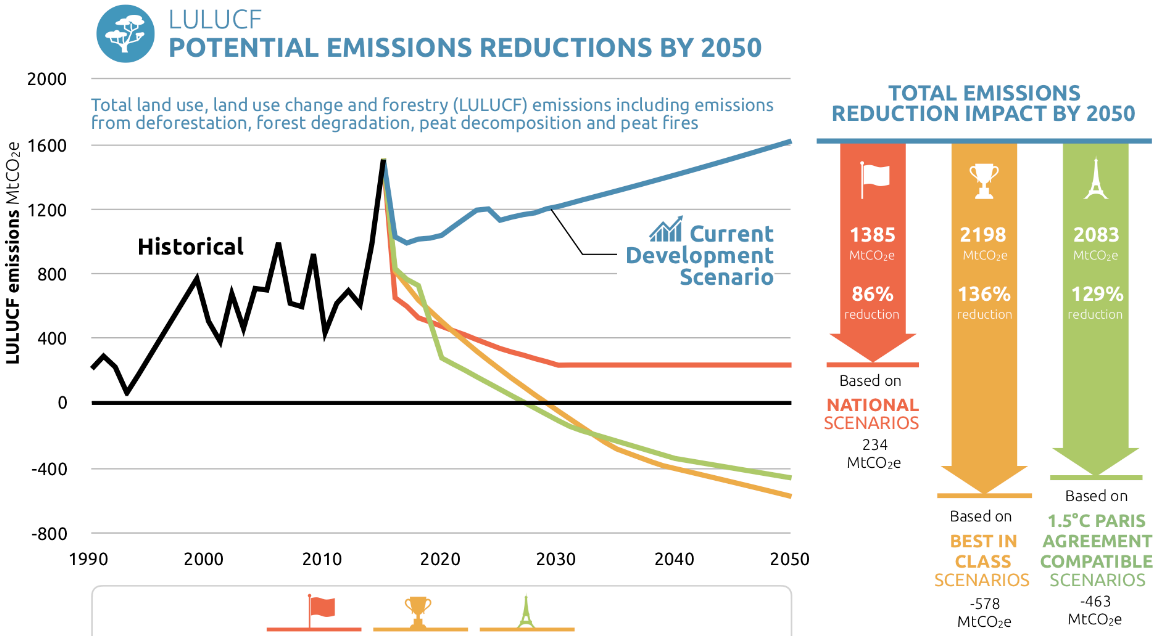
- **Deforestation, afforestation/reforestation:**
  - **Deforestation:** This indicator is based on historic levels of deforestation reported in Brazil, which have demonstrated highly effective policy in combating deforestation between 2005 and 2010, following its forestry law reform in 2006 (Bauch et al., 2009). This on average has led to an annual reduction of the deforestation rate of 12% within this period. Due to increased deforestation in Indonesia between 2010 and the last historical year, 2015, this results in a reduction of the deforestation rate **81% by 2030, 95% by 2040 and 99% by 2050**.
  - **Afforestation/reforestation:** This indicator is based on historic levels of afforestation and reforestation in India. India maintains an ambitious afforestation policy which has resulted in 2009 managed to achieve levels of around 1.1 million ha annually. If this is scaled with Indonesia's forest cover, this rate would equal around 1.4 million ha of forests that survive their first year, applying a forest survival rate of 90% observed in the US. This results in a net afforestation rate of **22.5 Mha by 2030, 36.2 Mha by 2040** and **51.8 Mha by 2050**.
- **Peatland restoration:** For this scenario, the progress that Indonesia itself has made in the past years on peatland restoration is taken as a best-in-class example. The level of peatland restoration Indonesia has achieved in 2017, around 200,000 ha, was unprecedented and exceeds what Europe has managed to restore in its entire history. This level of peatland restoration is extended until the total area of deforested and drained peatland has been restored (around 4.5 million ha). Other best practices on peatland restoration can be found in Belarus. During the 1950s, Belarus had some 2.5 million hectares occupied by natural mires. By the year 2000 around 0.5 million hectares were drained and damaged, which resulted in many wildfires between 1999 and 2002 and significant releases of CO_2 (Ramsar, 2017). This kickstarted action on peatland restoration, which has since then led to the restoration of around 50,000 hectares of degraded peatland. Russia has had a similar development, with around 6 million hectares of drained peatland up to 2010 and massive wildfires in the Moscow Oblast in that same year (Ethnoexpert, 2018). Since then, around 87,000 hectares of drained organic soils have been restored using ecological methods and fire prevention methods (UNFCCC, 2019). Restoration efforts witnessed in Belarus equal a compound annual growth factor of around -1%. These rates are lower than what Indonesia managed to achieve in 2017, so these are not used for this analysis. Applying an annual rate of restoration of 200,000 ha leads to a total area of restored peatland of **2.8 million ha by 2030** and **4.5 million ha by 2039**, which is the total level of deforested and drained peatland that was derived for 2015.

National scenarios

Recently published modelling results by Indonesian research institutions and intergovernmental bodies like the FAO inform the selection of the indicators on deforestation, afforestation/reforestation and peatland restoration for national scenarios in the Indonesian forestry and other land-use sector. The indicator value for deforestation is **47% by 2030**, and constant from there up to 2050 and **15.2 Mha by 2025** for afforestation and reforestation, which is maintained until 2050. For peatland restoration the national scenarios show a total area restored of **2 Mha by 2030, 2040** and **2050**. The range of indicator values have been informed by following modelling results:

- **Deforestation, afforestation/reforestation:** The indicator values for deforestation and afforestation/reforestation were based on the *Mitigation Scenario 2*, specified in Indonesia's Second National Communication under the UNFCCC (Indonesian Ministry of Environment and Forestry, 2010). The scenario contains a progressive target of afforestation/reforestation of 1.6 – 2.1 million hectares/year, up from the current rate which is around 0.9 million hectares/year. Deforestation is expected to decrease to 684 kha/year after the historically higher levels and remain constant. These targets are part of the forestry sector's Strategic Plan. However, these projections are defined up to 2025 in the SNC, and are extended to 2050 for the purpose of this assessment. No further afforestation/reforestation is assumed after 2025. This leads to a reduction in deforestation of 47% by 2030, which stays constant thereafter, and an afforestation rate of **15.2 Mha by 2025**, which is maintained thereafter.
- **Peatland restoration:** The Government of Indonesia, as a part of this same *Mitigation Scenario 2*, aims at restoring more than 2 million hectares of drained peatlands by 2030 and rehabilitating 12 million hectares of unproductive land (Hergoualc'h et al., 2018). In light of this commitment, President Joko Widodo established the Peatland Restoration Agency (BRG) in 2016, which has set the target of restoring 2.4 million hectares of peatland by 2021 in the seven key provinces of Indonesia. For the purpose of this study we apply the scenario defined in Indonesia's SNC. This leads to **2 Mha** of peatland being restored by 2030, which stays constant thereafter.

4.3.2.2 *Quantification of emission levels*



	National	Best in class	1.5°C Paris	
DEFORESTATION REDUCTION BY 2050	47%	99%	81%	percentage reduction of deforestation compared to 2010 levels
AFFORESTATION & REFORESTATION BY 2050	15.2	51.8	45	million hectares
DRAINED PEATLAND RESTORED BY 2050	2	4.5	4.5	million hectares restored

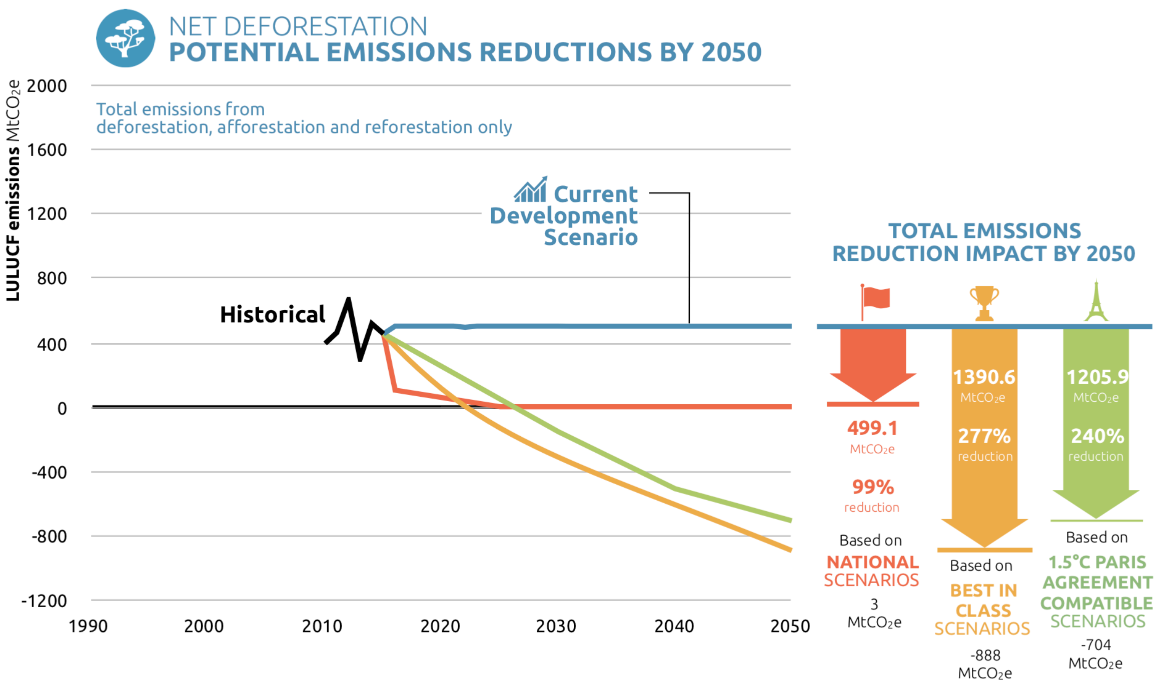


Figure 20: Overview of sectoral emission pathways under a business-as-usual scenario and different levels of accelerated climate action in the Indonesian forestry sector. Below graph shows net deforestation emissions, which includes deforestation and afforestation/reforestation. All sectoral projections towards 2050 done in a separate CAT forestry scenario evaluation tool, with emissions from the business-as-usual scenario based on Wijaya et al. (2016). Note that emissions in the upper graph are harmonized with emissions from Indonesia's GHG inventory, and that therefore emissions from deforestation are lower in this dataset compared to the data showed in the lower graph.

Figure 20 illustrates the emission ranges for emissions in the Indonesian forestry sector for various scenario definitions. The *current development scenario* sees emissions towards 2050 steadily increase due to the continued expansion of deforestation on peatland and associated increases in emissions from peatland decomposition and peat fires (Figure 21).

It should be noted that emissions from peat fires are highly variable and that the baseline sets out an average increase of these emissions. The baseline scenario was based on Wijaya et al. (2016). Many different estimates for Indonesia's baseline exist and all carry significant uncertainty, mainly since there are a number of conflicting commitments and policies. Most notably, the government has set a target to double the production of palm oil by 2020 compared to 2012, to 40 million tonnes of crude palm oil (CPO), and is expected to grow further to eight times this level in 2050 under business-as-usual (Ditjenbun, 2015; GAPKI, 2014). At the same time there is a moratorium on new concessions for mining and palm oil plantations. The baseline scenario based on Wijaya et al. (2016) assumes constant emissions from deforestation and forest degradation as reported in Indonesia's Forest Reference Emission Level (FREL) report (Ministry of Environment and Forestry, 2015). Although the baseline includes deforestation from palm oil expansion, depending on the rate of expansion and on which soil, the baseline would represent a conservative estimate of future emissions, and possibly an underestimate. However, if improvements in productivity of existing plantations can be achieved, rather than the expansion of production area, this could be an overestimation of emissions.

Emissions from peat decomposition are also based on the FREL submission and show a gradual but slow increase. Peat fire emissions are based on the Global Fire Emissions Database (Van der Werf, 2015). Despite conservative estimates for emissions in the context of ramping up palm oil production, emissions in this baseline scenario are significantly higher compared to Indonesia's NDC, which shows 714 $MtCO_2$ for the year 2030. This is because emissions from peat decomposition are not included in the NDC baseline, as well as emissions from the 2015 peat fires events (Wijaya et al., 2016). All pathways under accelerated climate action in the Indonesian forestry sector lead to emissions substantially lower than the current development scenario by 2050. The pathways vary in the level of emissions reached by 2050 and the distinct pathway trajectories, with some pathways managing to turn the sector into a net sink of CO_2 emissions:

- The '**1.5°C Paris Agreement compatible' pathway** sees a steep reduction and reaches a net-zero level just before 2030. This is mainly due deforestation that is reduced by around 74% compared to 2010 levels, which immediately shows results in a reduction of deforestation emissions, in addition to a complete halt of emissions from peat fires and peatland degradation which today make up the largest share of LULUCF emissions. Ambitious rates of afforestation and reforestation enable the pathway to become net-negative. After reaching net-negative emissions, the pathway stabilizes due to the progress that has been made in peatland restoration and the depleted mitigation potential in that area. Afforestation continues, but at a lower rate. The development seen in the deforestation pathway of this scenario is also supported by 1.5°C scenario literature, as all IPCC 1.5°C scenarios see a turning point from decreasing to increasing forest cover between 2020 and 2030.
- The **'Applying best-in-class levels' pathways** initially is more ambitious in terms of emissions reduction compared to the *1.5°C Paris Agreement compatible* pathway, and manages to get to net-zero emissions from deforestation faster, between 2020 and 2025. Continued reduction of emissions from peatland degradation and partly related peat fires make the pathway reach net-zero in 2030. After this point, net emissions keep decreasing fast due to underlying best practice policies on afforestation and reforestation that have been extrapolated until 2050.
- The **'National scenarios' pathway** contains the steepest reduction of emissions after the projection starts since the governments' '*Mitigation'* scenario from the First Biannual Update Report projects immediate ambitious reductions in deforestation and continued

restoration of degraded peatlands. However, since the Indonesia Ministry of Environment and Forestry does not have a scenario for forestry and peatland beyond 2030, the emissions stabilize around 250 $MtCO_2$/yr.

Table 19: Key indicators describing the scenarios for GHG emissions from the forestry sector in Indonesia for the period between 2015–2050.

Scenario	Year of peaking	Maximum rate of reduction [absolute reductions in $MtCO_2e$/yr]	Remaining emissions in 2050 [$MtCO_2e$/yr]
Business-as-usual scenario	No peaking	-	1,620
1.5°C Paris Agreement compatible	Immediate	225	-463
Applying best-in-class levels	Immediate	90	-578
National scenarios	Immediate	71	234

The total emissions from the LULUCF sector vary significantly between the different pathways, but are largely dictated by how fast the pathway manages to reduce deforestation and how much drained peatland is restored. The enormous maximum rate of reduction in the Paris Agreement compatible scenario originates from the reduction of peat fires by 2020. In the other scenarios peat fire emissions are reduced more simultaneously and in a linear relationship with peatland restoration efforts, since these not only also reduce the susceptibility of peatlands to peat fires during the dry season. As seen from the baseline emissions in Figure 21, these emissions make up a significant part of the LULUCF emissions and therefore have a large impact in the overall pathway emissions.

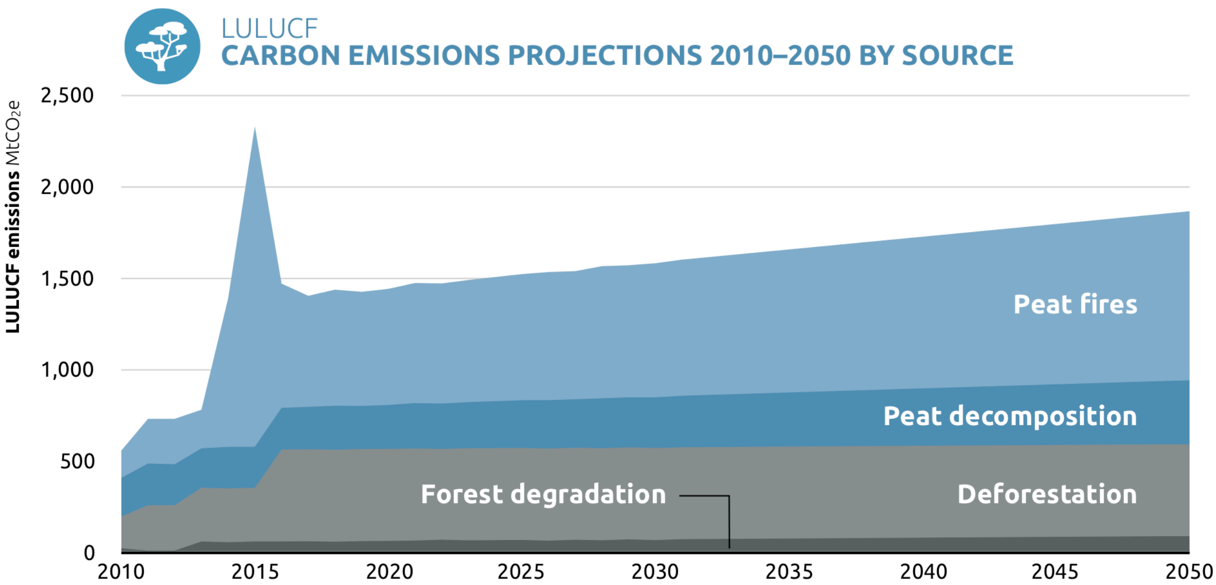


Figure 21: Baseline emissions for the various LULUCF categories until 2050 (adapted from Wijaya et al., 2016).

5 Conclusion

The analysis shows that up scaled mitigation action in the Indonesian electricity supply, passenger transport and forestry sectors alone can achieve a material reduction in emissions by 2030 (in comparison with current NDC that projects a significant growth of emissions). Proposed actions would enable the decarbonisation of these three sectors by mid-century, in line with a global Paris Agreement-compatible pathway. Further actions in all other sectors will be required to ensure economy-wide Paris Agreement-compatible developments.

Increasing climate action now would initiate technically-feasible and socio-economically beneficial sectoral transitions towards a zero-emissions society while directly benefitting Indonesia's sustainable development agenda. Our findings confirm that ambitious decarbonisation efforts in the three focus areas would significantly reduce greenhouse gas (GHG) emissions while simultaneously fostering co-benefits such as job-creation, reducing air pollution, reducing peat fires, conserving biodiversity, reducing traffic congestion in urban centres, promoting resource independency and increasing electrification of remote areas.

Recent developments in Indonesia and projected trends cast doubt on whether Indonesia will achieve sufficient mitigation to meet the Paris Agreement long term temperature goal. If Indonesia continues on its current path without taking any further climate action, the country's GHG emissions are projected to double by 2030 from 2012 levels.

For the electricity sector, a key priority is to stop coal development and assess the important implications of short and medium-term policy in Indonesia to avoid a high risk of stranded assets. The analysis suggests that to be Paris Agreement-compatible and reach complete decarbonisation by 2050, the most promising option is to fully transition the electricity sector to 100% renewable sources. Indonesia is well-endowed with a range of renewable energy sources, while deployment of nuclear power or fossil fuels with CCS is highly unlikely, and not considered a realistic option to decarbonise electricity generation.

Incentive programmes for hybrid vehicles and Indonesia's potential ban on fossil-fuel car sales by 2040 are a first step on the path toward achieving transport sector decarbonisation. To achieve the required level of emissions reductions in the long term, strong electrification of the passenger vehicle fleet is needed starting today. The LULUCF sector probably has the largest potential for reducing domestic emissions. The analysis highlights a series of policies to reduce emissions in this sector, including the moratorium on new oil palm development, stopping peat fires, rapidly reducing deforestation rates and restoring degraded peatlands, which can also reduce their susceptibility to the devastating peat fires that Indonesia has experienced in recent years.

KEY FINDINGS

- ⇨ Scaling up climate action in the electricity supply, passenger ground transport and forestry sectors, which together covered about 70% of Indonesia's emissions in 2014, would lead to curbing emissions growth and could achieve a 20% *reduction* in emissions below 2010 by 2030. This stands in stark contrast to the currently projected 58-68% emissions *increase* under Indonesia's Paris Agreement Nationally Determined Contribution (NDC). It would initiate Indonesia's transition towards zero emissions in line with the Paris Agreement and peak Indonesian GHG emissions excluding deforestation and land use shortly after 2030.

Electricity supply

- To bring Indonesia in line with the Paris Agreement and with full decarbonisation of the power sector by 2050 requires a share of decarbonised electricity generation of 50–54% by 2030, with no new coal plants and coal phased out by 2040. The most promising way to full decarbonisation is for Indonesia to prioritise developing renewables to make up a share of around 50% by 2030 and 100% by 2050. Such a pathway would deliver the greatest societal benefits and avoid large-scale early retirement of new coal-fired power plants.
- Decarbonising power is paramount to decarbonising other economic sectors. Electrifying Indonesian transport will only result in sufficiently large emission reductions when the domestic power supply is decarbonised.
- Ambitious climate policy in the Indonesian power sector can yield substantial employment benefits: development of solar PV will play a central role in a future low-carbon electricity system and our most ambitious renewables deployment scenario could create, on average, up to 290,000 additional direct jobs between 2020 and 2030.
- Job losses in the domestic coal supply chain (after 2025) are expected to be largely outweighed by additional new jobs in building and operating new renewables capacity. This shift will require preparation now to ensure a Just Transition.

Road and rail passenger transport

- As Indonesia's GDP grows, passenger transport demand is expected to grow substantially until 2030, by around 3% annually. Fuel economy standards, developing public transport and introducing electric mobility are key measures to start decreasing passenger transport emissions in the short term.
- Strong electrification of the passenger vehicle fleet, coupled with decarbonised electricity would enable decarbonisation of passenger transport and be in line with requirements of the Paris Agreement. Our most ambitious scenario assumes 100% electrification of the passenger vehicle fleet by 2050. Such an achievement would require going beyond, and sustaining, existing global best practices, e.g. the recent uptake of electric two-wheelers seen in China.
- These measures carry important co-benefits such as improving local air quality and reducing congestion in cities.
- Indonesia has a very ambitious biofuel blending policy. Biofuels could play a significant role in decarbonisation of the transport sector, although without additional measures related to governance and sustainability certification, palm oil biofuel production will continue to drive deforestation as oil palm plantations expand into Indonesia's primary forests.

Forestry

- Although ambitious interventions in all sectors are urgently needed to prevent fossil fuel lock-ins, the Indonesian forestry sector, with globally significant emissions peaking at 1.6 $GtCO_2e$ in 2015 (because of very high peat fires in that El Nino year), has the single largest potential for reducing domestic emissions.
- Indonesia can turn its forestry sector into a net sink of carbon emissions by 2030 if (1) it stops peat fires by 2020, (2) it drastically reduces or even phases out emissions from peat degradation via peat restoration by 2030 and (3) it ensures that emissions from deforestation are net-zero by rapidly reducing deforestation rates and reduce deforestation to almost zero by 2040, as well as mounting ambitious afforestation/reforestation programmes. This is more ambitious than Indonesia's NDC pledge under the Paris Agreement for the forestry sector.
- The 2015 peat fires in Indonesia have created political momentum to address this large source of emissions. But sub-national governments require more support to manage diverging interests among stakeholders, and land-swapping schemes for peatlands under concession require revisions to better meet all stakeholder needs. Its success would bring major co-benefits in avoided health impacts, environmental degradation and economic damage.

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