Implementing the Paris Agreement: Low-carbon urban transitions

A background paper for the German-Indonesian technology transfer workshop “Smart and Climate-Friendly City Solutions” taking place October 31st to November 1st, 2018, in Jakarta

Published by

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Abbreviations

CO_2	Carbon Dioxide
EPBD	European Energy Performance Building Directive
EPC	Energy Performance Contract
ESCO	Energy Service Company
EV	Electric vehicles
GDP	Gross domestic product
GHG	Greenhouse gases
IAM	Integrated assessment modelling
ICE	Internal combustion engine
LCEV	Low carbon emission vehicle

Contents

1 Low-carbon urban transition – An introduction

The world population is expected to rise to 9.8 billion people in 2050, of which 6 to 7 billion people are expected to live in cities (UN, 2017). Today, Asia accounts for about 60% of the global population and more than half of the world's urban population, although it is less urbanised than other regions in the world (UN, 2018a, 2017). Indonesia is slightly ahead of the region's urbanisation trend, with 73% of its population expected to live in cities by 2050. In comparison 84% of Germany's population is expected to live in urban areas by 2050 (UN, 2018b).

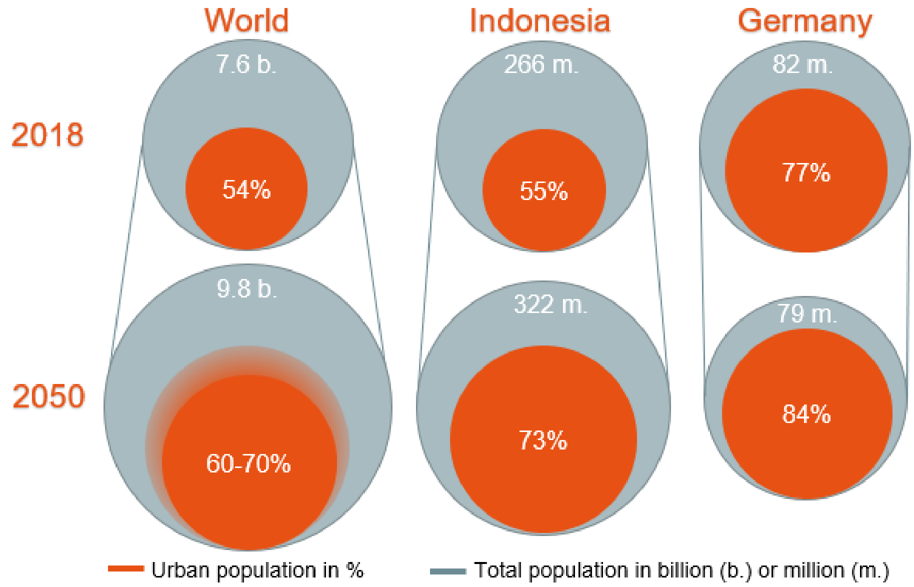

Figure 1: Urbanisation trends between 2018 and 2050, globally, in Indonesia and in Germany. Data source: (UN, 2017; UN DESA, 2015) (UN, 2018b) (UN, 2018a, 2017).

In 2015, the **urban population contributed 85% of the global GDP as well as 73% of global GHG emissions** while only representing 54% of the world's population (IEA, 2016; IRENA, 2017c; UN, 2018b).

Recent research demonstrates that immediate and stringent action in cities is critical for achieving the 2015 Paris Agreement goal to **limit the global temperature increase to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels as well as to decarbonise the global economy in the second half of the century** (ARUP and C40 Cities, 2016; Broekhoff et al., 2018; Day et al., 2018). Furthermore, cities play a major role in meeting human development goals and sustaining economic growth (Gouldson et al., 2018).

General urbanisation trends show that **cities will become more compact, more integrated, and more accessible** (Gouldson et al., 2018). Well-planned and developed cities, in the form of low-carbon transportation, low building energy use, compact urban form and efficient waste management, have a high potential to not only contribute to climate change mitigation but also to promote economically, socially and environmentally sustainable societies. Such synergies of climate change mitigation and urban development can lead to benefits, such as **job creation, improved public health, social inclusion, and improved quality of life** (Broekhoff et al., 2018; Day et al., 2018; UN, 2012). So-called co-benefits of climate change mitigation can be quantified as illustrated by three global examples (Day et al., 2018):

- **Residential energy efficiency retrofit** could create over 5 million jobs in cities worldwide, for regions where retrofit is an economically attractive climate change mitigation measure.
- **District-scale renewable energy for heating and cooling in buildings** could prevent over 300,000 premature ambient air pollution related deaths per year by 2030, as well as create jobs for around 8.3 million people.
- **Enhanced bus networks and bus services** could prevent the premature deaths of nearly 1 million people per year from air pollution related mortality and road traffic fatalities worldwide and save as much as 40 billion hours of commuter travel time each year by 2030.

Several cities have embraced the responsibility of being core polluters, as well as the opportunity arising from climate change mitigation. Many are active in setting climate-neutral targets, upscaling renewable energy production, enforcing regulations or incentives to limit industrial emissions, improve energy efficiency in buildings, develop smart technologies or encourage zero-emission transport and infrastructure (UNEP, 2018). Some cities launched international initiatives such as the C40 network of 40 cities worldwide, including Jakarta, Heidelberg and Berlin[1], which aims to advance climate change mitigation actions. By now, **27 of the C40 cities have reached emissions peaks and have successfully decoupled population and economic growth from GHG emissions** (C40 Cities, 2018).

In order to provide guidance on action required to meet the Paris Agreement temperature below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, the Climate Action Tracker (CAT) **identified ten short to medium-term benchmarks** that show what type of actions need to happen in order to achieve the highly ambitious 1.5°C Paris Agreement temperature goal (Kuramochi et al., 2017). **These benchmarks are derived from Integrated Assessment Modelling (IAM) scenario analyses on a global scale**. Countries and cities are subject to specific circumstances and capacities; therefore, their decarbonisation pathways can take different forms. Yet, we refer to these global benchmarks as they highlight the level of sectoral ambition the Paris Agreement temperature goals entail.

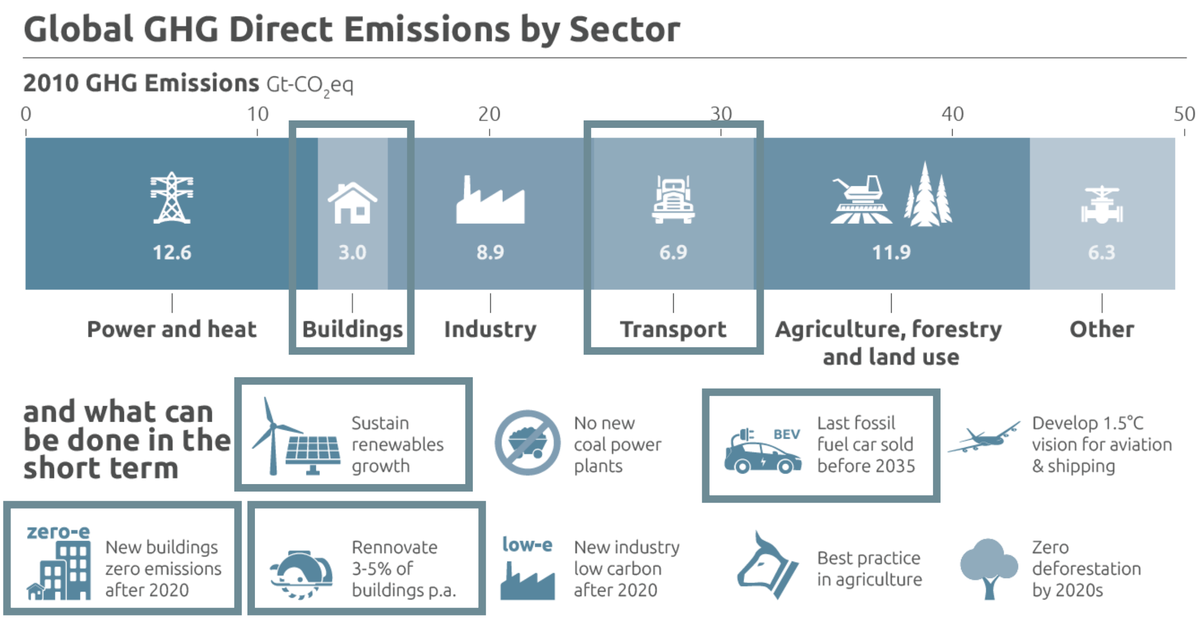

Figure 2: Global sectoral emissions and respective sectoral benchmarks (Kuramochi et al., 2017)

[1] A full overview of participating cities can be accessed under www.c40.org/cities.

In urban areas, two sectors are the main contributor to climate change: the buildings and transport sector (UNEP, 2018). Table 1 shows four benchmarks that are particularly relevant to cities and guide the analysis of this paper.

Table 1: Selected benchmarks relevant to cities for sectoral decarbonisation in line with the Paris Agreement temperature goals (Kuramochi et al., 2017)

Benchmark 1	Benchmark 2	Benchmark 3	Benchmark 4
Sustain renewables growth	zero-e New buildings zero emissions after 2020	Renovate 3-5% of buildings p.a.	BEV Last fossil fuel car sold before 2035

The paper is structured in two main parts, one on sustainable buildings, one on urban mobility. Each section follows the same structure. First, we explain the implication of the given sector to meet the Paris Agreement temperature goals and refer to the appropriate benchmarks. In a subsequent step we analyse the sectoral transitions in the country context for Germany and Indonesia. Finally, the concluding section identifies collaboration opportunities between Germany and Indonesia in these two sectors. In addition, the **Annex** – Case studies on sector transitions in the city of Berlin contains two case studies on ongoing sectoral transitions in the buildings and urban mobility sectors in the city of Berlin.

2 Low-carbon urban transition – Sustainable buildings

2.1 Implications of the Paris Agreement for the buildings sector

PA implications

The building sector currently represents a third of the global energy demand and is a key contributor to global GHG emissions (IEA, 2017a). To achieve the Paris Agreement goal to keep global warming well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, the building sector requires a rapid transformation towards full decarbonisation in the second half of the century. Hence, **buildings worldwide should transit to nearly zero energy buildings, also called climate neutral or passive houses, in particular newly constructed ones.** The European Energy Performance Building Directive (EPBD) defines nearly zero energy buildings as buildings that have a very high energy performance, complemented by significant use of renewable energy sources, preferably on-site.

Sectoral benchmarks

Table 2: Selected benchmarks for buildings sector decarbonization in line with the Paris Agreement temperature goals (Kuramochi et al., 2017)

	**Sustain the growth rate of renewable energy until 2025 to reach 100% by 2050**. In the building sector renewable energy installations take form in the use of district heating, the installation of thermal and electrical solar panels, or biomass heating systems.
	**All new buildings are fossil-free and near zero energy by 2020.** In order to achieve this goal, all new buildings should follow stringent building codes. Best practices exist around the world but not that many new buildings are climate neutral yet.
	**Increase renovation rates from <1% in 2015 to 5% by 2020.** Thermal retrofitting of the existing building stock needs to increase to a 3-5% annual rate.

Technical potential

Several pilot projects across Europe demonstrate that **it is technical possible to achieve nearly zero-energy buildings by implementing efficiency measures and renewable energy production**. For example, the Wuppertal University developed a comprehensive database with more than 330 real buildings worldwide from 1993 to 2013 that were retrofitted to nearly equalised energy balance (Musall et al., 2010). By modelling a Paris Agreement compatible pathway, Knobloch et al. (2018) found that **stringent policy instruments are needed** to implement such technologies and comply with the Paris Agreement goals.

Global key trends

As the building sector's climate relevance is mainly energy demand, the focus of climate action remains on **energy efficiency measures**. The integration of renewables (e.g. rooftop solar panels) also plays a significant role in the low carbon transition of the building sector. Mitigation measures which enhance energy performance can be carried out in three areas.

- **Altering the energy efficiency of the building envelope** is essential to reduce energy consumption. Climate change mitigation measures can require the installation of technology (active) or relate to the design (passive). Roofs, walls, windows and foundations are key to a well isolated building and strongly affect air leakage and thus heating, cooling and ventilation demand (IEA, 2013a). Many solutions already exist, such

Global key trends

as fiberglass or natural fibre insulation, PVC windows or automatic doors. Passive measures also increase energy efficiency quite significantly, such as the orientation of a building, windows, floor plans, or natural air flows.

- **Space heating and cooling and water heating** account for over half of the global building sector's energy use, thus they have an immense potential to reduce energy consumption. The choice of used heating and/or cooling technologies makes a significant contribution to energy efficiency savings. Some have high efficiency ratios and enable to produce heat or cooling with a lower energy input, such as different types of heat pumps or air conditioners. Other technologies enable on-site energy production such as thermal solar panels or biomass boilers (IEA, 2013a).
- **Lighting, cooking and appliances** represent 55% of total emissions in the building sector, with the majority coming from indirect emissions associated with electricity use. The accelerated uptake of most efficient technologies offers tremendous energy efficiency potential while avoiding negative rebound effects (Climate Action Tracker, 2018; IEA, 2013b). Examples of energy efficient technologies are LED light bulbs, induction cooking, or energy efficient washing machines. The combination of highly efficient appliances and decentralised renewable energy play a central role in extending energy access as well as clean cooking, particularly in rural communities (IEA, 2017b).

Conclusion

In the medium to long-term, the building sector has the potential to be fully decarbonised implementing state-of-the-art technologies and sector coupling with renewable energy production. Due to the longevity of buildings, both new buildings need to be constructed as efficient as possible and energy inefficient existing buildings stock need to be retrofitted. Technologies to do so are available and accessible, therefore it is important to initiate an accelerated uptake worldwide.

2.2 Buildings sector transition: the case of Germany

Climate targets

In Germany, the building sector bears the most ambitious climate targets among all sectors with 67-68% GHG emissions reduction by 2030 below 1990 levels. To do so, the German government plans to reduce the sector's primary energy demand by 80% compared to 2008 levels by 2050, of which 20% are to be achieved by 2020 and to more than double the thermal retrofit rate to 2% annually (Bundesregierung, 2010, BMUB, 2016). Furthermore, all buildings, including the existing building stock, are to be climate neutral by 2100, and all new buildings already by 2020.

Background

Germany has a **rather old building stock, as well as a low construction rate and long-lasting buildings**. Most buildings have very old and inefficient envelopes that are very costly to upgrade (Amecke et al., 2013; Bollmann, von Mallinckrodt, & Röttmer, 2018; OECD/IEA & IRENA, 2017). In the residential buildings sector, most buildings were constructed in post-war times, before the first energy efficiency ordinance of 1978, and therefore have a high primary energy demand (BMWi, 2014; Destatis, 2018a; Loga et al., 2012). Finally, the Germany residential housing sector faces a strong split- incentive dilemma as around 55 % of households live in rented dwellings (DeStatis, 2014).[2]

[2] Tenants lack an incentive to invest in energy efficiency measures when utility bills are included in the rent and they are most likely to move out before the investment pays back (Forni & Zajaros, 2014).

Current policies

To decarbonise the building sector, **the German government has put in place a wide range of policy instruments** (Bundesregierung, 2017). Figure 3 illustrates how these policies affect the buildings market. The core policy is the **Energy Saving Ordinance that sets minimum energy efficiency requirements**, which has been last updated in 2014. Policy instruments such as grants, loans, free energy advice and education aim to increase the number of buildings that are energy efficient (y-axis of *market share in %*). In contrast, policy measures such as building codes, mandatory energy performance certificates or research and development support increase the energy efficiency of buildings (x-axis of *energy efficiency of buildings*). **Well-designed policy instruments affect the impact and uptake of implemented action and increase the number of measures undertaken**.

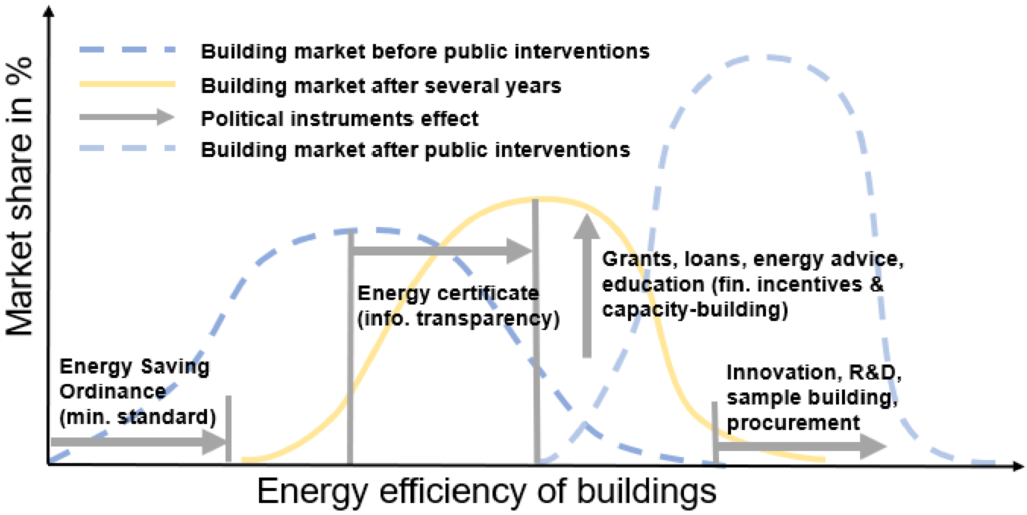

Figure 3: Prototype policy package and its theoretical effect on the building market. Source: (BMUB, 2017)

Key trends

Since the first energy ordinance (minimum energy efficiency standard) in 1978, the German construction sector has drastically evolved, due to more and more stringent building codes related to the energy demand of buildings. **Buildings constructed after 2015 consume 20% less energy than buildings constructed between 1948-1978** (BMWi, 2014; Destatis, 2018a; Kersten, 2014; Loga et al., 2012).

- **Building envelope:** Typical technologies include the use of more effective insulation materials (also green/eco materials) or insulating doors and windows (e.g. triple layered windows) (dena, 2018). In recent years, IT solutions have proven to play a role in efficient energy consumption and production, such as automated control systems, known as “smart buildings” (ibid.).
- **Space and water heating and space cooling:** Until 2000, most heating systems in new buildings were based on natural gas, but this technology has since been overtaken by **district heating, biomass boilers and heat pumps**. In contrast, between 1995 and 2015 natural gas gained 4,8% market share in the existing building stock, up to almost 50% market share in 1995, over the use of oil for heating which in turn lost 7,5% over the same period and is down to around a quarter market share in 2015 (AGEB, 2018).

- **Lighting, cooking and appliances:** In Germany, as in all EU Member States, LEDs are taking over the lighting sector and induction systems are the trend in cooking appliances. The German appliances sector, including refrigerators, televisions, and dishwashers, is subject to the EU energy efficiency labelling, which sets energy efficiency standards from A to F. The labels are updated every few years or when too many appliances reach the best standard, thereby continuously pushing efficiency improvements in the market (European Parliament and Council, 2017).

Although technologies to decarbonise the German buildings sector already exist, behavioural and financial barriers do not allow to reach an annual 3-5% retrofit rate required for a full decarbonization of the German buildings sector. Such barriers are, among others, a lack of awareness/information, high upfront cost for retrofit investments, or the split-incentive. Yet, in recent years, solutions such as **Energy Performance Contracts (EPCs)[3], a new business and financing model to overcome high up-front cost, have emerged, particularly in the public sector.**

2.3 Buildings sector transition: the case of Indonesia

Climate targets

Indonesia has set the minimum target to reduce its economy-wide GHG emissions by 26% by 2020 and 29% by 2030 compared to the BAU scenario (BAU scenario projects 2.9 $GtCO_2e$ in 2030). Under the condition of receiving international support, Indonesia committed to reach a 41% reduction by 2030 (CAT, 2015a; Republic of Indonesia, 2015). To do so, the country plans to increase the share of renewables from 4.3% in 2005 to at least 23% by 2025 and 31% by 2050 (CAT, 2015b; Government of Indonesia, 2014; Republic of Indonesia, 2008). **Furthermore, energy intensity is aimed to decrease by 1% each year and energy consumption to decrease by 17%, of which 15% shall originate from the commercial sector and households.** The energy savings target of 17% is based on a business-as-usual scenario with an average annual growth of energy demand of 7.1% per year, factoring in population growth and economic development (ibid.).

Background

The biggest electricity consumption in low-income households comes from refrigerators, whereas air conditioners are responsible for most electricity consumption in high-income households (Government of Indonesia, 2011a). The Indonesian buildings sector faces several barriers to implement more ambitious sectoral mitigation action, such as governmentally subsidised electricity prices for households, a lack of testing laboratories for energy performance, and lack of consumer awareness for energy efficiency savings.

[3] An *Energy Service Company (ESCO)* implements energy efficiency measures (which can also include renewable energy) and earns revenue from a part of the energy savings it guarantees.

Current policies

By 2025, the Indonesian government aims for all citizens to have electricity access, some of it provided by renewable energy sources. Furthermore, all government buildings should use the most energy efficient air conditioners and energy saving light bulbs (Indonesia State Ministry of Environment, 2007). In 2011, the country also put in place the National Energy Efficiency Standard for Buildings, which is a national building code that includes four standards (IEA, 2018a):

1. Energy conservation for building envelope (SNI 03-6389-2011)
2. Energy conservation for air conditioning system in building (SNI 03-6390-2011)
1. Energy conservation for lighting system in building, including standard of lighting intensity for the office, residential, industry, hospital, and malls (SNI 03-6197-2011)
2. Energy audit procedure for building (SNI 03-6196-2011)

The building code is complemented by the Energy Conservation regulation No. 70/2009, which allocates the responsibility to central and local governments as well as to the private sector to develop and implement standards and energy efficiency labels, financial incentives and information campaigns/guidance for energy-related products such as appliances (Government of Indonesia, 2011a).

Key trends and conclusion

Indonesia's construction sector has been growing in the recent years with a construction output growth of more than 6% annually between 2011-2016. **Indonesia's construction sector is expected to further thrive until 2021, especially by increasing investment in infrastructure, energy and residential projects (GlobalData, 2017).** Drivers such as ongoing industrialisation, urbanisation, and population growth provide additional boosts to the construction industry along with growing electricity demand, which the Ministry of Energy and Mineral Resources has planned to tackle with a ten-year electricity supply business plan for 2016–2025, called Rencana Umum Penyediaan Tenaga Listrik (RUPTL) (ibid.).

Jakarta's construction growth rate is one of the fastest in Asia and ahead of the Indonesian national average (ibid.). Jakarta's administrative office furthermore responded to the challenge of starting the buildings sector transition by **signing the 30:30 Commitment policy, which plans to reduce energy and water consumption and carbon emissions up to 30% by 2030**. Also, the Jakarta Green Building Implementation Grand Design should ensure more efficient compliance (Climate Bonds Initiative, 2018).

There are several non-state initiatives in Jakarta, such as the **Green Building Council Indonesia managing an Indonesian green buildings rating system called Greenship and the EDGE certification**. In addition, around 260 building managers in Jakarta have announced to comply with the recent green building regulations, accounting for a total of 15 million m^2. The Indonesian Government plans to act as role model by committing to use the latest technologies for upgrading its buildings and 'greening' tourism facilities (ibid).

Indonesia has revised some of its climate commitments in recent years, energy and climate related policies are spreading, particularly in the building sector. Indonesia has the potential to build a sustainable buildings sector through coupling with solar power generation and energy efficient appliances. **Because of the longevity of buildings and the currently growing construction sector, it is important that energy efficiency is considered at the early building design stage to avoid the need of costly and complicated retrofits later on.** Rapid population growth and urbanisation rates have the potential to increase demand for housing and commercial space in a more environmentally sustainable manner.

3 Low-carbon urban transition – Urban mobility

3.1 Implications of the Paris Agreement for the transport sector

PA implications

In 2015, there were 947 million passenger cars in use globally for 7.3 billion inhabitants, which means that almost every 8th citizen possessed a car on average (OICA, 2018; UN, 2015). The transport sector accounts for over a third of OECD's final energy consumption, which has quadrupled between 1971 and 2016. Also, while other sectors have a diversified energy mix, **the transport sector still predominantly relies on oil** (IEA, 2018b). To achieve the Paris Agreement temperature goals to keep global warming to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, this transport sector's reliance on oil needs to be overcome. To ensure that global warming remains below 1.5°C above pre-industrial levels, emissions would need to be reduced to between 0.8-4.1 $GtCO_2$ by 2050. This would mean reducing per capita emissions from the sector by up to 90% compared to current levels. According to Climate Action Tracker analysis (2018), "**zero-emission vehicles need to reach a dominant market share by around 2035** for the world to meet the Paris Agreement's lower warming limit of 1.5°C". To achieve this goal, a transition to electric vehicles (EV) is needed, yet **this transition requires the production of carbon-free electricity to be truly emission free** (ibid.).

Sectoral benchmarks

Table 3: Selected benchmarks for transport sector decarbonization in line with the Paris Agreement temperature goals (Kuramochi et al., 2017)

Sustain renewables growth	**Sustain the growth rate of renewable energy until 2025 to reach 100% by 2050**. The transport sector is becoming more reliant on carbon-free electricity with the uptake of EVs, therefore sustaining the growth of renewables is crucial to the transition of the transport sector.
Last fossil fuel car sold before 2035	**Electric vehicles shall constitute 100% of newly-sold vehicles by 2035.** Hydrogen-fueled cars might also gain increasing importance over time, yet on a short to medium term perpective, the uptake of EVs remains most crucial.
Last fossil fuel car sold before 2035	**Strong modal shifts are needed to decarbonise the entire sector.** While aviation and freight are expected to transit more slowly, a modal shift away from individual passenger cars to urban transportation systems has high potential to decrease sector emissions. Especially in urban agglomerations, a modal shift to public transportation, biking, and zero-emission cars offers significant potential.

Technical potential

Technical solutions to reach the Paris Agreement goal are available for the transport sector. However, political will is necessary to initiate the required sectoral transformation. According to the Climate Action Tracker (2018), governments would need to double their fuel standards and achieve an EV uptake of 50% to still stay below the 2°C level. If the aim is to limit global warming to below 1.5°C, actions must be even more ambitious.

The emission production potential of electric vehicles depends on the level of penetration of renewables in the generation mix, as a higher share of electric vehicles in the total vehicle fleet only leads to emission reduction if coupled with low-carbon electricity generation. Beyond that, an increase in EV can support the scaling up of renewables by providing storage capacity. The REmap estimates that 160 million EV are needed by 2030 to support variable renewables on a large scale (IRENA, 2017a). **Besides replacing combustion engines, a transition in the transport sector also means more**

and better utilization of public transport. Better infrastructure, e.g. charging facilities, utilization of digital technologies as well as mobilizing private capital will be key to the transition in the transport sector until 2050 (Agora Verkehrswende, 2017).

Key trends

If the current development continues without intervention, the emissions of the transport sector will rise by 60% until 2050 (OECD, 2017). According to projections of the international transport forum, global passenger demand will more than double until 2050. More specifically, urban mobility will grow by 95%, and the increase will be almost evenly distributed between private mobility and public transport. This growth mainly goes in hand with the economic progress in Asia (OECD, 2017).

The market for electric vehicles is continuously expanding in recent years. **In 2017, sales increased by 54% compared to the year before.** The countries with the highest development have been China and Norway, both of which also have the strongest policy push (IEA, 2018c). According to the IEA, there will be 127 million electric cars in 2030, a positive trend that will not be limited to light-duty vehicles but include trucks and buses. In the emission-intensive aviation sector, hydrogen engines may be a key solution (Liebreich, 2018). According to IRENA, there are several factors that will determine the uptake of EVs (IRENA, 2017a):

- **Technological advancement** such as the extension of the battery's driving range
- **Cost reduction** that allow electric vehicles to reach cost parity with internal combustion engines
- **Infrastructure development** such as charging stations in urban and rural areas
- **Policy framework** including financial purchase incentives as well as regulatory incentives (e.g. driving and parking access advantages).

Provided that our understanding of transport changes drastically in the next years, the proliferation of EVs could be greatly facilitated.

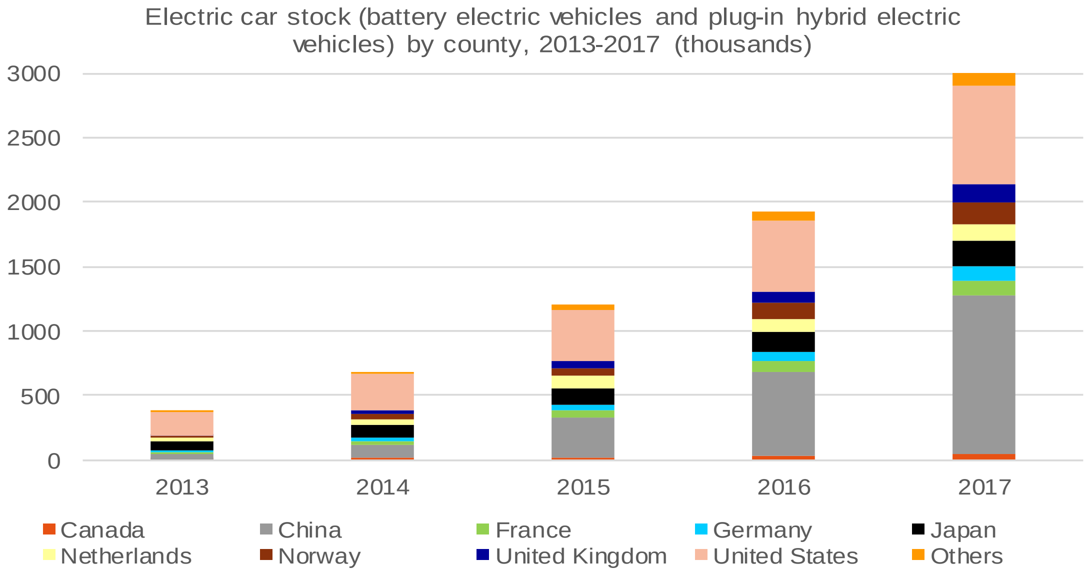

Figure 4: Electric car stock (battery electric vehicles and plug-in hybrid electric vehicles) by county, 2013-2017 (thousands). Source: (IEA, 2018c)

Conclusion

The transport sector is far from meeting the decarbonisation challenge on a global scale. Transport-related GHG emissions are steadily on the rise and policies so far have not resulted in an observable slowing of this trend at the global level. The sector will face a key challenge to phase out internal combustion vehicles while simultaneously accelerating the penetration of zero-emission vehicles and initiating a modal shift towards public transportation in urban agglomerations

3.2 Urban mobility transition: the case of Germany

Climate targets

After agriculture, the transport sector has the least ambitious climate targets: the German government plans to **reduce the country's GHG emissions by 40-42% by 2030 below 1990 levels** (BMUB, 2016) and achieve a 10% reduction of the primary energy demand by 2020, taking 2005 levels as a reference (BMWi, 2018a). The contribution of the transport sector towards achieving this, includes the target of **one million electric vehicles in circulation by 2020 and six million by 2030** (BMWi and BMU, 2010).

Background

As of today, Germany has failed to reduce GHG emissions from the transport sector. The sector's final energy consumption, and thus its GHG emissions have even increased in recent years, as much as by 2.9% in 2016, accounting for 29% of total final energy consumption in Germany (BMWi, 2018b; Vieweg et al., 2017a). **Even though average consumption per 100km fell by 7.5% between 2005 and 2016 for passenger cars and light commercial vehicles, traffic volume in passenger transport has increased by 11% since 2005** (and as much as 21.7% for freight transport) (BMWi, 2018b). In 2017, there were 45.8 million registered cars in Germany, which means that statistically more than half of the total population possesses a car (Destatis, 2018b, 2018c). Furthermore, most cities in Germany fail to keep limit values for nitrogen dioxide (NO2) of 40 µg / m³, as 44% of urban air traffic monitoring stations registered emissions exceeding the limit in 2017 (UBA, 2018). For example, all four largest cities Berlin, Munich, Hamburg, and Cologne fail to do so.

Current policies

This overview outlines four implemented policies in the German transportation sector:

- **Car efficiency standards** regulate CO_2 emissions of vehicles and thus have a direct impact on the fuel consumption of the vehicles. The government sets reductions targets that the auto industry needs to comply with. This policy facilitates an electric vehicle (EV) uptake, as these cars do not rely on fuel combustion and thus have no direct emissions. Furthermore, the Volkswagen scandal, followed by many other German car-makers, has shown that even though the industry was outperforming the government-set goals, **an important discrepancy between "on paper" emissions from test scenarios and the real fuel use on the roads exists** (Vieweg et al., 2017b).
- **Energy and vehicle tax:** The energy tax is a quantity-based fuel tax but has no relation to the energy content or GHG emissions of various fuels. For example, diesel fuel is taxed 18.4 € cents per litre less than gasoline, although its energy content is higher as are its emissions per litre. After deducting the vehicle tax (which is higher for diesel-fuelled cars), such cars benefit from 1.5 billion euros subsidies per year (BMWi, 2018b; Vieweg et al., 2017b).

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- **Umweltbonus** (environmental bonus) is a programme launched by the German Government in 2016 that provides subsidies for at least 300.000 “new, for the first time approved, electrically operated vehicles”. Half of the environmental bonus is borne by car manufacturers and the other half by the federal government (BAFA, 2016).
- **The promotion of public transport** exists throughout Germany, although policies are not necessarily implemented on a national level and are more indirect. For example, public transportation can be deducted from taxes and student and job tickets are widespread and subsidised. Cities play a major role as they manage urban planning and infrastructure.

Key trends

The Climate Action Plan 2050 emphasises the role of transport and will further promote such measures as electric mobility, exploring possibilities of sector-coupling, modal split and digitalisation of traffic (BMUB, 2016). On the EU level, the **discrepancy between vehicles' emission performance between test scenarios and real use cases has led to the latest revision of the CO_2 regulation** in three ways: 1. Introduction of new, more realistic test cycle, the Worldwide Harmonized Light Vehicles Test Procedure (WLTP), 2. Introduction of In-Service Conformity Tests (to verify emission data during the use phase) and 3. On-board fuel meters (fuel consumption meters) (BMWi, 2018b).

In February 2018, the German Supreme Federal Court ruled that **cities can enforce traffic bans on diesel-fuelled cars** in order to reach the EU regulation to limit emissions of nitrogen dioxide (NO2) of 40 µg/m³ (Bundesverwaltungsgericht, 2018). This led to an ongoing debate between clean air in cities (diesel ban) and the financial risk for car owners that currently own diesel-fuelled vehicles (diesel subsidies).

The market penetration of innovative vehicle technologies falls short of initial expectations (Wolfram et al., 2016). Although, by the end of 2018, the biggest German car-makers have launched or are planning to launch their own EV lines.

3.3 Urban mobility transition: the case of Indonesia

Climate targets

The **National Action Plan to reduce GHG emissions (RAN-GRK),** as the overarching GHG mitigation framework in Indonesia, outlines concrete fields for action for the Indonesian transport sector (Government of Indonesia, 2011b). These include plans for the development of a Bus-Rapid Transit (BRT) system, electrification of the railway system but also road pricing and eco-driving measures (Republic, 2011). The overall sector-wide emission reduction target is 26% below business-as-usual by 2020 for all sectors covered in the Plan. The actions do not specify any sector-wide emission reduction targets.

Background

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. About 1 million motor vehicles and 7.5 million motorcycles and scooters will be added each year to Indonesia's roads until 2030 (IRENA, 2017b). This trend will further exacerbate the already severe air pollution in urban centres. The National Energy Plan envisages 184 million motorcycles on the road in 2030, of which 4 million should be electric motorcycles.

Currently implemented policies

Indonesia has implemented several climate strategies and policies in the transport sector, which have been enforced to varying degrees. In the following, four main policies are outlined in more detail.

- The Ministry of Transportation developed the **Sustainable Urban Transport Programme Indonesia (NAMA SUTRI)** in 2012 (Ministry of Transportation, 2014). 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. Five pilot cities were selected and asked to develop demonstration projects for the improvement of public transport, mainly around Bus-Rapid Transit systems, and transport demand management.
- In early 2017, Industry Minister Airlangga Hartarto announced that the Indonesian Government is preparing a **Low Carbon Emission Vehicle (LCEV) programme** (Suzuki, 2017a). An important element of the policy will be the provision of tax breaks for hybrid vehicles. 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. 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 2040 (Suzuki, 2017b).
- **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 (ICCT, 2016). The four sectors included are 1) transportation, 2) electricity, 3) industry and commercial and 4) micro-business, fisheries, agriculture and public services.
- **Emissions performance standards** foresee that Euro 4 emission standards are scheduled to apply to gasoline light-duty vehicles (LDVs) starting in September 2018 and diesel vehicles in April 2021. Currently the Euro 2 standards are in place for this category (MoEF Regulation No. 04/2009). Indonesia also has standards in place for motorcycles, which, since 2015, need to comply with Euro 3 standards if these have an engine displacement greater than 50 cm^3. Three wheelers and other motorcycles are subject to Euro 2 standards (MoEF Regulation No. 23/2012).

Key trends and conclusion

The announcement by the Indonesian Ministry of Energy and Resources to introduce a ban on fossil-fuel vehicles in the draft presidential regulation of the LCEV programme for the year 2040 would imply a significant sectoral shift in line with the required phase-out of fossil fuelled cars. Simultaneously, Indonesia is developing a Low Carbon Emission Vehicle programme, aimed at incentivising low-carbon and electric vehicles. Remaining ICE vehicles are subject to an ambitious biofuel mandate, which sets a 30% blending target for 2030.

These announced sector strategies and policies, if implemented, would be in line with the global transport sector benchmark with the last fossil fuel powered car sold before 2035–2050 to achieve car fleets consisting of 100% zero-emission cars by 2050–2065. However, Indonesian urban agglomerations will face significant challenges to implement and manage the required urban mobility transition considering the rapid urban population growth and the respective growth in urban mobility demand.

4 Opportunities for cooperation between Indonesia and Germany

4.1 Cooperation potential 1: Exchange on best practices for the buildings sector

Although the Indonesian and German building sectors are marked by country and climate-specific challenges, developing energy efficient buildings and integrating renewable energy technologies are applicable in both countries. Germany and Indonesia have elaborated national plans and regulations to initiate the sector's transition to decarbonisation.

In context of these recent development, cooperation potential between Indonesian and German partners exists on exchanging expertise in state-of-the-art construction practices of 'green buildings' and relevant technologies. Such technologies in the Indonesian country context comprise for example building automation systems, energy efficient natural-refrigerant-based cooling systems.

4.2 Cooperation potential 2: Exchange on best practices for the transport sector

Indonesia and Germany face different challenges in the transition of urban transportation systems due to the size of urban agglomerations, the predominant modes of transports, as well as the type and pace of the urban expansion. Nonetheless, significant potential exists for the exchange of available urban transportation technologies, particularly in the field of electrified private and urban transport. In the context of the rapid ongoing urbanisation in many Indonesian agglomerations and a respective increase in demand for mobility, the uptake of smart and low-carbon technologies remains crucial to successfully manage the sector transition and reduce adverse impacts of combustion-based transportation on human health.

Germany has successfully initiated exchanges on electric mobility with international partners. For example, German and Brazilian partners have been discussing opportunities for a successful implementation of charging infrastructure and standards, electrified public and commercial transportation, as well as electric vehicle production in a matchmaking workshop hosted by the NDE Germany and NDE Brazil in March 2017.[4] Similar exchanges on technologies related to digitalization in mobility, electrical public transport and infrastructure, the nationwide uptake of electrical scooters and buses, as well as electrification of the railway system, offer significant potential for successful cooperation between German and Indonesian partners.

4.3 Cooperation potential 3: Coordination on low-carbon urban development

City administrations from Indonesian and German cities have opportunities to initiate meaningful exchange and long-term cooperation on low-carbon urban development. While problems and challenges at hand might be diverse in the different country contexts, intra-city cooperation through city initiatives such as C40 - including Jakarta, Heidelberg and Berlin - offer a platform to exchange experiences, further strengthen and streamline city-level action, as well as increase ambition levels for action in different sectors such as residential buildings, urban mobility, and local industries.

The cooperation between city administrations and practitioners enables urban agglomerations to become innovation hubs for research cooperation on technology development and deployment considering country and city specific circumstances. Furthermore, a structured exchange offers

[4] The background paper 'E-Mobility – Cooperation potential between Germany and Brazil' can be accessed on the NDE Germany's website here. https://www.nde-germany.de/fileadmin/user_upload/Invitation_to_German-brazilian_climate_technology_transfer.pdf

significant potential to develop and implement smart systems for city planning and management, addressing challenges of rapid urbanisation in an integrated manner.

Annex – Case studies on sector transitions in the city of Berlin

The following case studies overview the current planning and implementation status of a residential buildings sector transition (see Box 1) and urban mobility transition (see Box 2) in the city of Berlin.

Box 1: Overview of the residential buildings sector transition in the city of Berlin

Building sector transition: Berlin

Sectoral impact: 41 % of the city's emissions and 60% of its electricity consumption

Berlin's target: Become a climate-neutral city, i.e. a 95% reduction in CO_2 emissions in comparison to 1990 by 2050

Population: 3.6 million inhabitants, 1.8 million households, density of 4 039 inhabitants / km²

Characteristics: Many old Wilhelminian-style buildings, high share of green open spaces

Challenges: Growing population, shortage of housing

Two main policy pillars that drive the transition of Berlin toward a carbon neutral city are the *Berlin Energy and Climate Protection Programme (BEK)* of the year 2018, which is a result of a series of urban dialogues, and the *Berlin Turnaround Act* as amended in 2017.

The latter includes the targets to increase the average energy-related renovation rate to 2% per year by 2030, a goal that is in line with the nation-wide *Energiewende*. Currently, Berlin is at 1% refurbishment rate per year, which is higher than the national average of 0.8%

One noteworthy project is the *Energy Saving Partnership (ESP),* which started in 1996 and is conducted by the Berlin Energy Agency. The aim of the Partnership is to retrofit both private and public buildings to improve energy efficiency. The investment costs are not carried by the building users, but an Energy Service Company (ESCO), which is refinanced based on the guaranteed savings of the project.

The population increase will be dealt with through the dedensification of already existing residential areas and high energetic standards for new buildings.

Berlin aims to become a carbon neutral city by the year of 2050. The building sector will play a key role in this transition, as it is the sector with the highest CO_2 emissions. Some trade-offs will arise when designing carbon neutral living spaces. For example, open spaces can be used as carbon sinks, but at the same time re-densification is a key aspect of urban development.

Source: (BMU, 2012; C40 Cities, 2011; Hirschl and Harnisch, 2016; Senatverwaltung für Umwelt, 2016)

Box 2: Overview of the urban mobility sector transition in the city of Berlin

Urban mobility transition: Berlin

Sectoral emissions: Traffic causes 25% of CO_2 emissions while road traffic causes 70% of those emissions

Berlin's target: Become a climate-neutral city, i.e. a 95% reduction in CO_2 emissions in comparison to 1990, 30% non-fossil fuel cars by 2030, reduce car mobility by 17% in favour of 'eco-mobility', i.e. public passenger transport, walking and cycling

Background information: 3.6 million inhabitants, 4039 per km²just 342 cars per 1,000 inhabitants (federal average 547)

Characteristics: Increasing use of eco-friendly modes of mobility, which can be seen in Berlin's modal split

Challenges: Increasing population, growing economy which further burdens the city's infrastructure

The structure of a city has the potential to change and changing the modal split of transportation is key to the transformation. Thus, Berlin's urban planning includes strengthening of foot- and cycle paths, developing open public spaces, designing pedestrian-friendly traffic light phases, increase of crosswalks for pedestrians' safety, better lighting and crossing aids. The city also plans to increase "shared spaces", not only for cars, but also bikes.

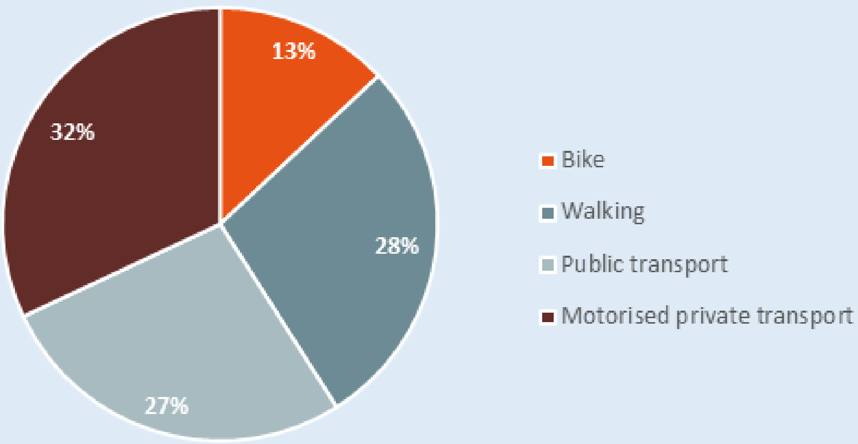

Figure 5: Modal split of the city of Berlin in 2017. Source: Wissenschaftliche Dienste, 2017.

Current policy initiatives aim to shift urban mobility in Berlin to climate-friendly modes of transport such as biking and public transportation. However, the city administration still needs to fully develop a comprehensive and integrated long-term innovation strategy to assure the decarbonisation of the urban transport sector.

Source: (C40 Cities, 2011; Hirschl and Harnisch, 2016; Senatverwaltung für Umwelt, 2016; Wissenschaftliche Dienste, 2017)

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