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The METRASYS Working Papers are work in progress documents, which intend to provide an
input into the development of scenarios for transport in the city of Hefei, China.

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1 Drivers for change in Hefei

There are a number of drivers affecting transport in Hefei over the coming decades. Drivers will shape future dynamics in predictable and unpredictable ways. These factors influence the transport sector’s strategic environment through social, technological, economic, environmental, and political changes. Few drivers are relatively certain over the next twenty to thirty years. Most drivers, such as the structure and size of the regional economy, demographic changes, shifts in social values and prices of energy and carbon are very hard to forecast for the long-term. The key driving forces are called the critical uncertainties and while all drivers are important, they are not equally important. The following section outlines these drivers to provide some background on the strategic environment for scenarios for the future of transport in Hefei.

1.1 Population growth and demographic change

The Hefei City Region Master Plan expects the population of the city to be almost 9 million by 2030 and 10 million including the surrounding areas (Table 1).

<table>
<thead>
<tr>
<th>District</th>
<th>Urban population (thousand people)</th>
<th>Land use area (km2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central urban area</td>
<td>500</td>
<td>490</td>
</tr>
<tr>
<td>Dianbu</td>
<td>79-155</td>
<td>85-150</td>
</tr>
<tr>
<td>Shangpai</td>
<td>70-140</td>
<td>80-140</td>
</tr>
<tr>
<td>Nangang</td>
<td>50-80</td>
<td>55-80</td>
</tr>
<tr>
<td>Shuangdun</td>
<td>82-130</td>
<td>85-130</td>
</tr>
</tbody>
</table>

The percentage of population over the age of 60 is expected to almost double by 2050 from 11% today to 22%. China will soon be experiencing an unprecedented ageing rate of its population, comparable to many advanced economies. This will result in a major shift in its population structure.
1.1.1 Urbanisation
The trend towards urbanisation will continue. Cities are driving the global economy and have become hubs of innovation and the exchange of ideas.\footnote{OECD (2006) Competitive Cities in the Global Economy, Paris.} Cities help knowledge exchange and social interaction that promotes innovation, entrepreneurialism and technological advancement, which in turn drives growth and productivity improvements. People are attracted to cities because they want to capture the opportunities for personal advancement. Over 70% of the world’s population is predicted to be living in cities by the middle of the century. This compares to just over 50% currently.\footnote{United Nations (2008) World Urbanization Prospects, New York.} Over the last decades China’s urban population has grown exceptionally fast. Forecasts indicate that Hefei, along with other cities in China is likely to experience increased demand for transport infrastructure over the next twenty years, through population growth and demand for freight transport. The need to manage this growth effectively and maximise transport efficiencies will require an integrated concept that addresses energy demand, carbon and harmful emissions, congestion, pressures on infrastructure, urban amenity and quality of life, and access and mobility.

1.2 Economic development
Globalisation has transformed the world in the last 200 years and it will continue to increase over the coming years.\footnote{UN (2009) World Economic Situation and Prospects 2010, New York.} It is characterised by increasing trade, knowledge transfers, economic integration, labour migration and capital mobility and is facilitated by trade liberalisation, decreasing transport costs and the expansion of information and communications technology. Globalisation encourages innovation and the exchange of ideas while allowing greater specialisation and division of labour to capture comparative advantages.\footnote{OECD (2010) Measuring Globalisation: OECD Economic Globalisation Indicators 2010, Paris.} These factors contribute to productivity improvement and economic growth. While globalisation will continue to be a driver of economic growth, it will also be a source of risk, as domestic markets become increasingly exposed to volatilities and competition in the global economy.\footnote{IMF (2010) WORLD ECONOMIC OUTLOOK, Rebalancing Growth, Washington, DC.} Emerging markets will continue to influence future growth around the global economy. China surpassed Japan in 2010 to become the world’s second largest economy. By the middle of this century China is likely to become the largest economy and India the second largest in terms of GDP.\footnote{Goldman Sachs (2010) BRICs Monthly, May 2010.} As Hefei is part of this rapid economic transformation, new opportunities will arise for the city, but also pressures on transport and energy demand and natural resources will intensify.
1.3 Energy and climate

Personal and freight transport demand, triggered by economic and population growth, is likely to double by 2050, boosting demand on an increasingly scarce resource.\(^7\) As a result, the global economy is facing a massive energy security challenge.\(^8\) Oil production from non-OPEC countries is already at plateau and by 2015, growth in the production of easily accessible oil and gas will not match the projected rate of demand growth.\(^9\) Decline in the availability of low-cost conventional oil is likely to keep the price of oil over US$100 over the medium-term, with increases potentially reaching $200 per barrel by 2030, which will put constraints on mobility and transport affordability in Hefei, if the city moves to more energy intense modes of transportation.\(^10\) The rapid increase of travel demand and the growing vehicle fleet in Hefei are accompanied by substantially growing greenhouse gas emissions and pollutants (Figure 2).

![Figure 2 Transport CO2 emissions and distribution for Hefei (BAU) 2001 – 2030](source: CATS/WI 2011)

1.4 Technological innovation

New and improved technologies will create opportunities to improve the efficiency of transport, and to make transport cleaner and safer. Innovation in transport has introduced technologies that have progressively reduced journey times, increased fuel efficiency, improved safety, provided greater trade opportunities, and enhanced social linkages around the world. While the overall pace and direction of technological change will continue to be largely driven by market forces, initial research and early adoption is likely to remain dependent on government support.\(^11\) Land transport technology still overwhelmingly relies on conventional petrol and diesel engines. Their

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\(^7\) Shell (2008) Shell Energy Scenarios,
energy density and portability is still unmatched and the manufacturing costs are considerably lower than any other technology currently available.\footnote{International Transport Forum (2011) Greenhouse Gas Emission Reduction Strategies in the Transport Sector, Paris.} Other technologies, such as natural gas, battery electric, and hybrids, make up a very small proportion of the world’s vehicle fleet, even though their share is growing. The IEA (2008) considers it is highly likely that internal combustion powered vehicles (traditional and hybridised) will continue to dominate the vehicle fleet composition for many years.\footnote{IEA (2008), Energy Technology Perspectives, Paris.} While electric vehicles are likely to be introduced into the transport system of Hefei, they are likely to account only for a very small share of the vehicle fleet over the coming twenty years.

## 2 Hefei 2030 – a business-as-usual scenario case

### 2.1 Urban development

The business-as-usual (BAU) case explored in this section is based on current developments and official plans and documents of the city government of Hefei, most notably the five-year plan and the draft Hefei City Region Master Plan 2010-2030. This scenario will explore developments in the city and its transport system that are the most likely under current policy settings and infrastructure plans. Hefei has experienced a period of rapid urbanization since the start of the Great Construction program in 2006 and is likely to continue to do so over the coming decades under any reasonable scenario. To accommodate this growth there will continue to be substantial investments in urban transport infrastructure along with the development of new residential and commercial areas. One example of this is the upscale of the road network in the new urban district near the Caohu Lake. The Binhu New City will become the new commercial centre of Hefei over the coming two decades. However, the city government aims for a multi-centred urban development approach for Hefei. This development strategy for Hefei out to 2030 envisages a spatial plan structured around one old town area, surrounded by four sub central urban areas and the Binhu New City as commercial centre, which collectively will form the urban area of Hefei. The draft Master Plan also accommodates for nine sub-urban centres that provide urban amenities and services and house industrial areas and technology innovation parks. These nine small cities will be developed around existing town centres as satellite cities surrounding Hefei’s main urban area. The cities are planned to provide a mixture of residential areas and employment opportunities.

Under the draft Master Plan, Binhu New City is planned to become the main city centre and central business district. Its functions will include administration, offices, commercial districts, conference and exhibition, and entertainment. The Sanxiaokou Business District in the old town around the People’s Square and Huaihe Road Pedestrian Street will focus on tourism, recreation and culture, as well as parts of the business district, primarily finance. Huaihe Road Pedestrian
Street, Middle Changjiang Road, Suzhou Road, West Changjiang Road and Shengli Road are planned to be the main commercial areas. Traditional cultural sites in the area will attract tourism and enhance entertainment functions of the district (Figure 4).

**Abbildung 3 Spatial plan for Hefei 2030**

Source: Draft Master Plan - Hefei 2030

### 2.1.1 Transport infrastructure development

To accommodate the projected population growth, economic development and urban sprawl, under a BAU scenario, substantial transport infrastructure investments are required. While the role of public transport and its integration is emphasised in current planning documents the focus is primarily on road construction, which will induce a remarkable growth of individual transport demand. To mitigate this it will be a key task for Hefei’s city government to provide access to public transport services, not only in the urban area, but also sub-urban and rural districts. The public transport system will be a mixture of regular bus services, BRT lines and

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metro rail. Inter-city and urban-rural buses will connect the urban area with periphery. The draft Master Plan envisages an access rate to public transport of 100% by 2030 for city and rural districts, which can be considered as very ambitious.

A transport hub is planned for construction in the south of the old town area, which will aim to integrate road, bus, metro and high-speed rail. This transport hub will also be the key connection between the old town area and Binhu New City. The inter-city high speed trains, regional trains, local metro (subway line 1, line 4 and line 5 are planned to be connected here), BRT, urban and inter-city buses, taxi service, urban highways and bicycle lanes will be connected in the transport hub to allow interchange between transport modes. The draft Master Plan estimates that in 2030 the transport hub will serve 400,000 passengers a day. At peak time about 10,000 people will board and bus, metro or train every hour. Hefei will continue to rely on the elevated highways to connect the outer districts with the city centre. The planned metro system will provide an efficient alternative, but the plans beyond the two metro lines currently under construction are still unclear. The draft Master Plan aims for seven metro lines (with a total length of about 200 km), which would form the metro network in the central urban area by 2025. Another five metro lines may be developed after 2025 to improve the connectivity outside the central urban area. Primary focus will be on elevated roads and ring roads to meet the increasing transport demand.\textsuperscript{15}

2.2 Vehicle fleet in Hefei in 2030

The size and shape of the vehicle fleet is a vital factor of the energy consumption and hence harmful and greenhouse gas emissions. Under a business as usual scenario the vehicle fleet the vehicle fleet in the city of Hefei can be expected to grow almost rapidly, from currently about 200,000 cars to over 1.8 million by 2030 (Figure 4). This figure is based on annual growth rates of 18.1% over the first five years declining to 5.5% by 2030.

Figure 4 Vehicle fleet development (individual transport) 2010 – 2030 (BAU case)

Source: CATS/WI 2011

Electric cars will remain a niche product in Hefei with only 4,000 in the fleet by 2030. E-bikes will increase slightly to over 14,000 by 2030 up from 10,000 today and conventionally powered motorcycles will disappear in Hefei by 2030 due to ban on new registrations. The number of diesel powered heavy-duty vehicles is expected to grow tenfold from 17,600 to over 17,000 by 2030.

The number of taxis in Hefei is projected to increase only marginally from 8,855 now to 12,750 by 2030, due to the high cost of taxi permits in the city. The number of buses is expected to almost double from currently 2,896 to 5,232 by 2030, which is however, a considerably lower growth rate than the one projected for private cars.
While there will be some diversification in the propulsion technologies in the public bus fleet the majority of the buses will still rely on fossil fuels mainly diesel and CNG with Petrol stagnating. However, electric buses will play a bigger role with about 600 electric powered buses in the fleet by 2030.

**Figure 5** Vehicle technology for the public bus fleet 2010 – 2030 (BAU case)

Source: CATS/WI 2011

Similar to the bus fleet the number of electric vehicles will increase, but play only a minor role with 1600 electrics compared to almost 12,000 CNG powered taxis by 2030. Petrol is playing an even smaller role than electric propulsion by 2030 and Diesel will have disappeared entirely by 2030 under this scenario.

**Figure 6** Vehicle technology for the public bus fleet 2010 – 2030 (BAU case)

Source: CATS/WI 2011
### Table 7 Hefei vehicle fleet 2010 – 2030 (BAU case)

<table>
<thead>
<tr>
<th>Mode</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Bus (Petrol)</td>
<td>284</td>
<td>284</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Public Bus (Diesel)</td>
<td>1672</td>
<td>2071</td>
<td>2372</td>
<td>2572</td>
<td>2672</td>
</tr>
<tr>
<td>Public Bus (CNG)</td>
<td>760</td>
<td>960</td>
<td>1160</td>
<td>1360</td>
<td>1560</td>
</tr>
<tr>
<td>Public Bus (Electric)</td>
<td>180</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>Taxi (Petrol)</td>
<td>405</td>
<td>505</td>
<td>605</td>
<td>705</td>
<td>905</td>
</tr>
<tr>
<td>Taxi (Diesel)</td>
<td>103</td>
<td>53</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Taxi (CNG)</td>
<td>8347</td>
<td>9347</td>
<td>10147</td>
<td>10947</td>
<td>11847</td>
</tr>
<tr>
<td>Taxi (Electric)</td>
<td>0</td>
<td>400</td>
<td>800</td>
<td>1200</td>
<td>1600</td>
</tr>
<tr>
<td>Car (Petrol)</td>
<td>271610</td>
<td>622853</td>
<td>1015228</td>
<td>1425853</td>
<td>1863853</td>
</tr>
<tr>
<td>Car (Electric)</td>
<td>0</td>
<td>2000</td>
<td>3000</td>
<td>3500</td>
<td>4000</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>46190</td>
<td>35400</td>
<td>9083</td>
<td>989</td>
<td>0</td>
</tr>
<tr>
<td>Heavy Duty Vehicles (Diesel)</td>
<td>17670</td>
<td>28020</td>
<td>51044</td>
<td>93854</td>
<td>174601</td>
</tr>
<tr>
<td>E-bike</td>
<td>10000</td>
<td>11000</td>
<td>12100</td>
<td>13310</td>
<td>14641</td>
</tr>
</tbody>
</table>

Source: CATS/WI 2011
References

IMF (2010) WORLD ECONOMIC OUTLOOK, Rebalancing Growth, Washington, DC.
IEA (2008), Energy Technology Perspectives, Paris.