

## 1. Supplementary materials

### Appendix A: TIAM-IFPEN

TIAM-IFPEN is a well-established version of the global TIAM model developed under the Energy Technology Systems Analysis Program of the International Energy Agency (IEA-ETSAP). It is a bottom-up integrated assessment model based on the TIMES generator.

#### ❖ GDP and population scenarios

The evolution of the GDP and population have been extracted, respectively, from the IEA and the UN population division (UN, 2019). World population rises to about 9.7 billion in 2050 in the median scenario, while world GDP (ppp)<sup>1</sup> grows to US\$283,500 billion in 2050.

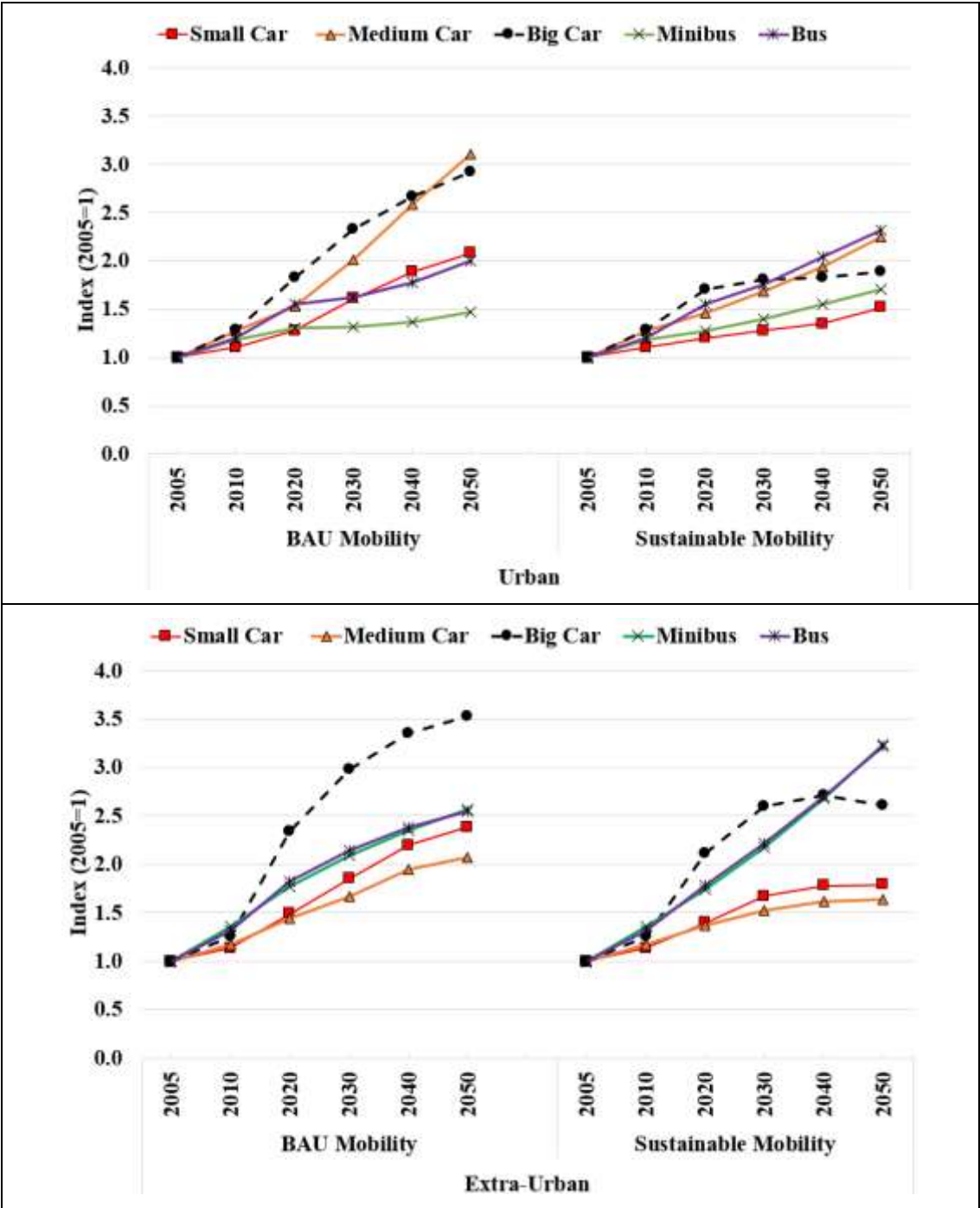
#### ❖ Mobility scenarios

The different mobility (BAU and Sustainable) demands have been derived from the IEA MoMo model (Fulton et al., 2009) with a disaggregation by vehicle size and by short and long distance (urban and extra-urban mobility) (Fig. 1). These two mobility scenarios are used to analyze the impact of a public policy on the development of the transport sector, and therefore the consumption of raw materials, in a context of climate constraints.

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<sup>1</sup> GDP at purchasing power parity

**Fig. 1 : Evolution of the two different shape of mobility (BAU and Sustainable) according to the travel mode (Urban and Extra-Urban)**

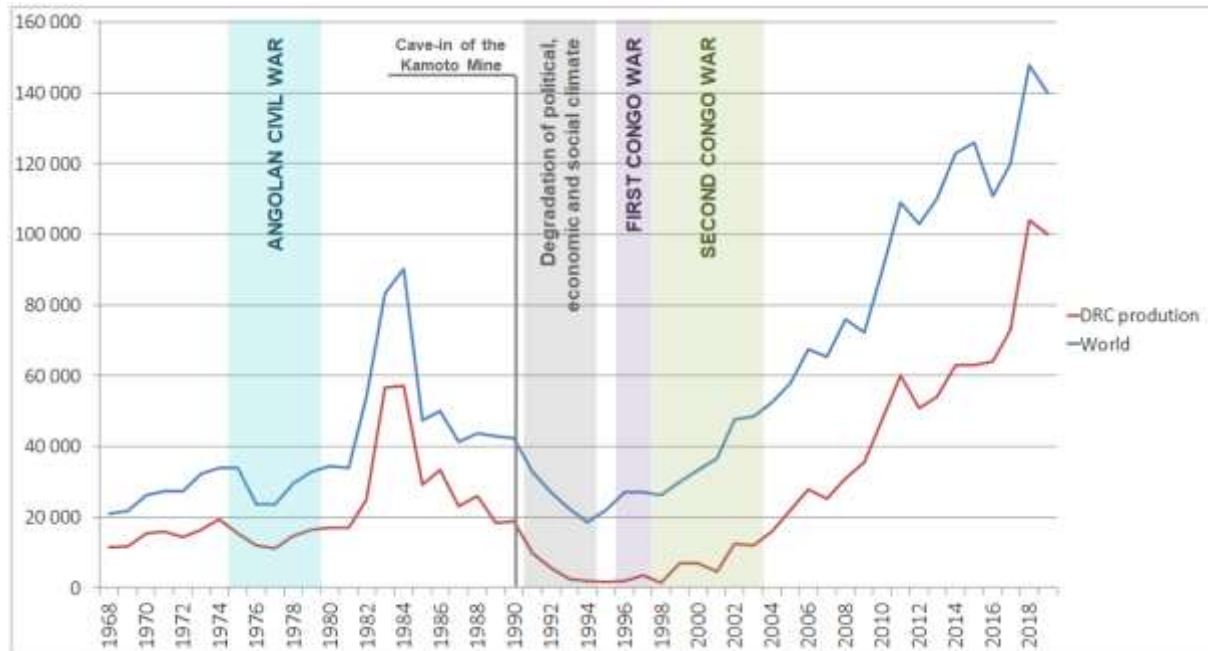




Source: IEA Mobility model 2019

## Appendix B

**Fig. 2: Zaire/Democratic Republic of the Congo cobalt mine production (metal content) from 1968 to 2019**



Source: (USGS, 1932-1993), (USGS, 1994-2016), (Shedd, 2000-2020)

**Table 1: Cobalt supply disruptions since the 1970s**

| Year | Event nature                               | Event  | Impact  |
|------|--|--|---|
| 1975 | Business and political climate uncertainty | Suspension of the <i>Société Minière de Tenke Fungurume</i> (SMTF) copper-cobalt project because of the uncertain climate generated by the civil war taking place in Angola.   | Delay or suspension of copper-cobalt projects   |
| 1976 | Political and social unrest                | Supply shortage from Zaire after bridges along commercial roads (Benguela Railroad) used by Zaire were damaged in the Angolan civil war.   | Supply shortage   |
| 1977 | Conflict Political and social unrest       | Invasion of the Shaba Province was invaded by troops coming from Angola: <ul style="list-style-type: none"> <li>Disturbance of the commercial roads because the Benguela Railroad remained closed.</li> <li>Delay of transmission line and expansion projects or downscaling of projects.</li> </ul>                                   | Production decline  |
| 1978 | Conflict Political and social unrest       | Invasion of the mining city of Kolwesi in Shaba province by the FLNC ( <i>Front National pour la Libération du Congo</i> ): <ul style="list-style-type: none"> <li>Takeover of copper and cobalt mines</li> <li>Repatriation of foreign employees</li> </ul>   | Disruption of refining and extractions activities                                     |
| 1986 |  | Obsolescence of the Mining facilities and equipment.   | Production decline  |
| 1990 | Industrial accident                        | Collapse of Gécamines' main underground copper-cobalt mine (Kamoto).   | Production decline  |
| 1991 | Political and social unrest                | Difficulties in completing the democratization process generating political, social and economic unrest: <ul style="list-style-type: none"> <li>Riots and looting spread from Kinshasa to the mining regions.</li> <li>Destruction of Gécamines' office in Kolwesi.</li> <li>Withdrawal of international financial support.</li> </ul> | Production decline<br>Interruption of production<br>Lack of maintenance of facilities |
| 1992 | Political and social unrest                | Persistent political and social unrest.  | Production decline<br>Lack of maintenance of  |

|      |  |   |  |
|------|--|---|--|
|      |  |   | facilities   |
| 1993 | Political and social unrest                                  | Persistent political and social unrest.   | Production decline (Zaire fell from being 1 <sup>st</sup> world producer to 6 <sup>th</sup> )<br>Lack of maintenance of facilities |
| 1997 | Political and social unrest<br>Conflict                      | Takeover of the country by military forces opposed to the government of Zaire. The country is renamed Democratic Republic of Congo.   | Production decline<br>Lack of maintenance of facilities  |
| 1998 | Political and social unrest<br>Conflict                      | Rebellion led by soldiers opposed to the new government.  | Delay or suspension of copper-cobalt projects<br>Decline of industrial production and rise of artisanal mining                     |
| 1999 | Political and social unrest<br>Conflict                      | Rebellion led by soldiers opposed to the new government.  | Delay or suspension of copper-cobalt projects<br>Decline of industrial production and rise of artisanal mining                     |
| 2000 | Political and social unrest<br>Conflict<br>Corporate failure | Rebellion led by soldiers opposed to the new government.<br>Revocation of a joint venture contract between Gécamines, the Government of Congo (Kinshasa), and Ridgepointe Overseas Developments Ltd by the Ministry of Mines. | Delay or suspension of copper-cobalt projects  |
| 2007 | Change in legislation  | Official forbiddance of unprocessed cobalt ores exports declared by the Government of Katanga province.   | Decrease of total cobalt exports   |

Source: (USGS, 1932-1993), (USGS, 1994-2016), (Shedd, 2000-2020)