

Supplementary Materials: Table S1: Data used in the case study of Xiong'an New Area.

The construction of UUTs is completed successively, so it is supposed for ease of calculation that the project would be finished in 2020, along with the beginning of the benefits. The time horizon of the benefit evaluation is 100 years from 2020 to 2120, which corresponds to the designed service life of the UUTs. The data and calculations in the table follow the requirements of the calculation methods proposed in section 3.2., with all unit prices presented according to the monetary value in 2020. E&R: excavation and reinstatement.

| Benefit category | Item | Amount | Unit | Notes |
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| | Evaluation period | 100 | year | 2020–2120 |
| | Social discount rate | 8 | % | |
| | Annual growth rates | 8 | % | |
| Benefit of conserving land and space B_1 | Annual amount of B_1 | 146.15 | CNY mn./year | |
| | General cross-sectional area of a set of all six types of directly buried utility pipelines | 60 | m ² | As presented in section 3.2.1. |
| | The average cross-sectional area of the UUT | 30 | m ² | Different types of cross section are designed for UUTs mainlines and branches in Xiong'an; the average area is calculated in length-weighted terms. |
| | Section height of the UUT | 3.9 | m | |
| | The corrected land price of underground space | 5000 | CNY/m ² | A rough arithmetic mean value of underground space with all types of uses according to the latest document regarding the benchmark land price provided by The People's Government of Beijing Municipality; a price for use rights of 50 years, which is simply doubled in the calculation. |
| | Total length of the UUTs | 190 | km | Ninety kilometers of mainlines and 100 km of branches. Water supply pipes, electricity pipes and telecoms pipes are accommodated in the whole UUT (190 km), while gas pipes and heating pipes are only accommodated in UUT mainlines (90 km). |
| Benefit of reducing the wastage of resources B_2 | Annual amount of B_2 | 35.43 | CNY mn./year | A correction factor of 0.9 is adopted considering that UUTs cannot prevent leakage entirely. |
| | The volume of lost water of urban water supply in Beijing throughout 2016 | 20,607.73 | 10,000 m ³ | According to China Urban Construction Statistical Yearbook 2016; with a total length of water supply pipes in Beijing of 15,741.63 km. |
| | The volume of lost natural gas of urban gas supply in Beijing throughout 2016 | 83,968 | 10,000 m ³ | With a total length of natural gas supply pipes in Beijing of 23,574.58 km. |

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| | The weight of lost liquefied petroleum gas (LPG) of urban gas supply in Beijing throughout 2016 | 19,340 | t | With a total length of LPG supply pipes in Beijing of 405.1 km. |
| | Average price of natural gas in Beijing | 2.5 | CNY/m ³ | |
| | Average price of LPG in Beijing | 2.67 | CNY/kg | A total of 40 CNY for each can, which contains 15 kg of LPG. |
| | Average price of water in Beijing | 8 | CNY/m ³ | |
| Benefit of avoiding disruption to local business B_3 | Annual amount of B_3 | 121.46 | CNY mn./year | |
| | Average annual turnover of a commercial road section | 500 | Million CNY | Conservatively, we treat the average annual turnover of a single mall or market as the average annual turnover of the whole street section. |
| | Percentage of decreased sales when affected by E&R procedures | 17.5 | % | Adapted from previous studies [24, 59, 61]. |
| | Number of commercial road sections with UUTs buried beneath | 63.3 | Sections | About one-sixth of all the road sections with UUTs buried beneath; estimated based on the regulatory detailed plan for the starting area of Xiong'an New Area (2020-2035). |
| | The number of pipelines E&R days for every road section | 8 | Days/road section·year | Supposing every road section requires an emergency repair of two days each year and a maintenance of 12 days every two years based on practical engineering experience. |
| Benefit of avoiding traffic delays B_4 | Annual amount of B_4 | 142.29 | CNY mn./year | Using the base approach recommended by the World Bank as shown in section 3.2.4. |
| | Number of road sections with UUTs buried beneath | 380 | Sections | Estimated based on the regulatory detailed plan for starting area of Xiong'an New Area (2020-2035). |
| | The extra time a pedestrian needed to pass through the E&R affected street section | 5 | Minutes | Adapted from practical experience and simplified calculation of evacuation. |
| | Average number of pedestrians during peak hours per street section | 2000 | People/hour | With data for pedestrian flow lacking, the average passenger flow of more than 200 subway stations in Beijing Metro Network during peak hours is taken as an estimation here, and 4 hours as rush hours. |
| | Average wages of employees in Beijing | 53 | CNY/hour | Taking 45 CNY/hour in 2018 with an average annual growth rate of 9% in the past 10 years according to data from Beijing Municipal Human Resources and Social Security Bureau. |

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| Benefit of conserving the service life of pavement B_5 | Annual amount of B_5 | 0.35 | CNY mn./year | The percentage of pavement service life loss taken as 0.3 according to the study of Tighe et al. [13] without adaption for lacking relevant research; correction factor taken as 0.8. |
| | Construction cost of pavements | 200 | CNY/m ² | According to the Budget Quota of Municipal Engineering in Beijing, including costs of materials, equipment, labor and etc. |
| | Average service life of pavements | 15 | Years | Using different block materials, the service life of block pavement can be either 10 years or 20 years according to the code for the pavement design of urban road. |
| | The average area of construction site for a pipeline E&R procedure | 150 | m ² | Supposing the site is 50 meters long and 3 meters wide, leaving a one-meter-wide space for pedestrians to walk through. |
| Benefit of conserving aboveground public space B_6 | | — | | As traditional utility lines in Xiong'an New Area lie underneath sidewalks and greenbelts only, the benefit here is neglected. |
| Benefit of reducing serious accidents of urban pipelines B_7 | Annual amount of B_7 | 5.84 | CNY mn./year | |
| | Proportion of gas pipeline accidents in all massive pipeline accidents | 54.6 | % | According to 2009–2013 statistics from Underground Pipeline Committee of China Association of City Planning. |
| | The average number of gas pipeline accidents per unit length of pipe in Beijing | 0.015 | Case/year·km | Estimated based on the data provided by Beijing gas Refco Group Ltd [82, 83]. |
| | Average direct economic loss per case in Beijing | 0.5 | CNY mn./case | Estimated based on years of accident reports in Beijing, in which gas pipeline accidents usually lead to hundreds of thousands of CNY of direct economic losses and sometimes cause millions or more in severe cases. |
| | Average annual number of deaths due to natural gas pipe accidents | 9 | People/year | According to data from 2012 to 2015 in Beijing gathered by Liu et al. [84]; averaging 0.025 deaths each case. The number of injuries is not provided, and is simply taken as 10 times that of deaths based on available materials such as accident reports in China. |
| | Average life span in Beijing | 82.2 | Years | According to latest report from Beijing Municipal Health Commission. The years of life lost is simply estimated as half of the local average life span for accidental deaths caused by gas pipeline accidents. |

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| | GDP per head in Beijing | 1.8 | CNY mn. | GDP per head in Beijing in 2019 is 1.64 million CNY and has maintained an average annual growth rate of 10% in the past five years. |
| | Average duration of convalescence | 0.5 | Year | A rough estimation based on available materials such as accident reports in China. |
| | Average annual working hours in Beijing | 2096 | Hour/year | According to <i>Prices and Earnings Around the Globe 2018</i> by United Bank of Switzerland (UBS). |
| Benefit of enhancing urban resistance against natural disasters B_8 | Annual amount of B_8 | 848.05 | CNY mn. | Calculated as the direct economic loss of pipelines replacement plus 90% of the total indirect economic loss of an earthquake since it is believed that most of the indirect loss is caused by lifeline project failures. Supposed to be generated once throughout the 100 years of the UUT service life. |
| | Replacement cost of directly buried water distribution pipes | 254800 | CNY/km | According to government documents on the Charging Standard for the Paid Use of UUTs in Shenzhen and Xiamen. |
| | Replacement cost of directly buried gas supply pipes | 2380200 | CNY/km | |
| | Replacement cost of directly buried electricity transmission lines | 6395300 | CNY/km | |
| | Replacement cost of directly buried telecoms lines | 1395000 | CNY/km | |
| | Replacement cost of directly buried heating pipes | 990000 | CNY/km | |
| | Loss ratio for lifeline projects | 56 | % | |
| | | 46 | % | For seriously damaged electricity pipes and telecoms pipes; same source as above. |
| | Correction factor of usage (public use for UUTs) | 1.1 | | Same source as above. |
| | Correction factor of economic development level (comparatively developed for Xiong'an New Area) | 1.15 | | Same source as above. |
| | Length of damaged pipes in proportion to total length of pipes | 2.4 | % | Estimated based on available materials such as reports of major disasters worldwide [85]. |

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| | Proportion of direct economic cost of pipeline damage in total direct economic cost of a major disaster | 7.3 | % | Estimated based on earthquake damage statistics of Yunnan Province from 1993 to 2003, collected by the team of authors. |
| | Ratio of indirect loss on direct loss of earthquakes | 2.5 | | Estimated based on statistics of the direct and indirect loss of previous earthquakes in China from 1976 to 2000, collected by the author team. |
| Benefit of avoiding dust, noise and visual pollution B_9 | Annual amount of B_9 | 142.35 | CNY mn./year | About 65% of the respondents stated willingness to pay to be rid of E&R pollution by adopting UUTs. |
| | Average annual fee publics are willing to pay for getting rid of E&R pollution (including dust, noise and visual intrusion) | 219 | CNY/(person-year) | An online questionnaire survey was conducted by the authors in 2018, Shanghai. Open-ended questions were applied to determine the amount of money each respondent was willing to pay to get rid of the dust, noise and visual pollution caused by E&R procedures in the road. In total, 218 copies of valid questionnaire were withdrawn, with 142 of them stating willingness to pay, and the mean WTP was 219 CNY per person each year. The acceptable sampling error was 6.8%. A retest was not carried out because of the insufficient time gap. |
| | Expected population density | 10000 | Persons /km ² (of land for construction) | With land for construction predicted to cover an area of 100 km ² , as suggested in the regulatory detailed plan for starting area of Xiong'an New Area (2020-2035). |