Dense and Transit-oriented Urban Development

Annex A of the Handbook 'Navigating Transport NAMAs'

TRANSfer Project – Towards climate-friendly transport technologies and measures

The concept

Transport energy consumption is inversely proportional to the density of the city. Furthermore, the way the city is organised influences the length of day-to-day travel distances and the access to public transport (PT). The organisation of housing, businesses, shops and leisure services determines how far people have to travel to go to work, to buy groceries or to visit a hairdresser. A dense mixture of different functions (office buildings, shops, apartments) can reduce travel activities and trip lengths and influences modal choice. There is a strong need to increase or maintain density and avoid urban sprawl, even if new settlements exceed municipal boundaries.

Elements of dense and transit-oriented urban development:

- Densification of existing city districts (through master planning, building codes and building programmes);
- Foster Transit-oriented Development (TOD);
- Integrate local and regional transport and Land Use Planning (LUP).

For more details on the elements' characteristics see the following Box 1.

Table 1: GHG reduction matrix of dense and Transit-oriented Development (TOD)

	Avoid	Shift	Improve
Direct effects	☑ Reduces intra-urban travel distances	☑ Improves the accessibility of public transport	☑ Increases the occupancy rate of public transport vehicles
Indirect effects	☑ Reduces car-ownership	☑ Shorter travel distances can increase the share of non-motorised modes	
Rebound effect	⌦ New transit oriented settlement structures at the city border can attract inner city residents		
Complementary measures *(to achieve full mitigation potential)*	☑ Provide convenient and secure public space (see Factsheet '*High Quality Walking Infrastructure*') ☑ Install pedestrian zones for local shopping ☑ Develop green belts for local recreation	☑ High quality cycling and walking infrastructure (see Factsheet '*High Quality Walking Infrastructure*') ☑ 'Public Transport First' strategy (see Factsheet "'*Public Transport First' Strategy*") ☑ Parking management (see Factsheet '*Sustainable Parking Management*') ☑ Speed restriction (see Factsheet '*Economic and Regulatory Instruments for Road Traffic*')	☑ Green procurement of PT vehicles (see Factsheet '*Green Mobility Management*')

On behalf of

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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of the Federal Republic of Germany

Box 1: Possible elements of dense and Transit-oriented Development (TOD)

Densification of existing city districts (through master planning, building codes and building programmes)

Many cities grow at their boundaries. More and more residents and companies settle in the area around the city, whereas the inner city becomes a Central Business District (CBD) or even loses its relevance. In Europe, large industries have left the inner areas and huge brownfields are left behind. These areas can be used for new building structures to maintain a high inner city density.

Often, shops or office buildings as well as luxury flats are constructed in the core of the city to maximise rental incomes. Sustainable densification, however, also includes the development of standard housing. This also prevents night time security problems on "empty" streets.

Concrete measures to be taken are:

- Revise the urban master plan and development objectives towards higher density.
- Revise existing building codes to foster high density and mixed use (institutional capacity necessary).
- Provide an urban housing programme following the principle of mixed land use.
- Conduct traffic impact assessment (TIC) for newly developed areas in order to find best solutions.

To quantify the effect of urban density on energy consumption and GHG emissions, Norman *et al.,* (2006) compare a low-density (19 dwellings/hectare) residential settlement structure at the urban fringe of the city of Toronto and a high-density (150 dwellings/hectare) residential structure close to the city centre. The authors find that in the low-density area, per capita GHG emissions from transport are four times as high as in the high-density settlement. Considering also differences in building materials and operation as well as infrastructure manufacturing, the GHG emission per low-density resident are 2 to 2.5 times as high as the emissions of high-density residents.

How it works and intended effects:

- Mixed use buildings reduce average trip lengths.
- Dense urban structure makes public transport more profitable and efficient.
- Upgrading of the inner city can reduce suburbanisation trends.
  - ➔ Travel distances are limited and trips are avoided.
  - ➔ Public transport, walking and cycling becomes more attractive.

To be considered for implementation:

- Long-term measure, since infill development takes several years.
- Developing countries metropolises that change at a fast pace are in the best position to induce densification of city structures now.
- Support from foreign investors might be necessary.
- Benefit: the city can raise building taxes or leasing rates that reflect the enhanced value of inner-city areas.

Responsible actor: Local land use planning departments

Foster Transit-oriented Development (TOD)

TOD comprises a set of different smart land use measures. TOD aims to increase the density of commercial and residential development along public transport corridors and stations. Public transport stations are supported as centres of local commercial activity. Furthermore, employment places and services like health care are close to the public transport station. Within walking distance, the centre is surrounded by high-density residential structures. Thus, residents can reach many facilities by foot and longer distances can easily be travelled by public transport.

The concept of TOD can be included in land use planning (see above) and can be easily applied to new urban structures. Furthermore, TOD strategies can be included in urban redevelopment projects to improve existing structures (Broaddus *et al.,* 2010).

How it works and intended effects:

- Reduces trip lengths.
  - ➔ Reduces the emissions per trip.
  - ➔ Increases the share of non-motorised modes.
- Increases the accessibility of public transport.
  - ➔ Makes a shift from private motorised modes to public transport more likely.

To be considered for implementation:

- Include TOD in master plans and building codes.
- Let public transport operators benefit from land value increases around public transport stations (*e.g.* Hong Kong).
- TOD is a long-term measure; it takes years until the measure is fully effective but the effects are lasting.

Responsible actor: Local land use planning departments

Integrate regional and local transport and land use planning

As outlined earlier, land use and transport planning are closely interrelated. Merging urban development and transport planning authorities is an option to improve the coordination between transport and land use planning.

Moreover, land use and transport planning needs coordination across administrative levels as many cities grow beyond their administrative borders. Rapid population growth or suburbanisation trends of residents or investors lead to an expansion of the urban area. Sometimes neighbouring towns or villages are enclosed by the urban agglomerations over time. Commuter travel or freight transport from these new settlement structures largely influences traffic within the municipal boundary. It is essential to coordinate the development across the whole urbanised region to avoid adverse structures and traffic patterns. The best approach is to develop coordinated plans that cover the whole region. However, the city government lacks the authority to influence the land use and transport planning decision across municipal borders. Therefore, local and regional authorities could be asked to cooperate and agree upon an integrated development plan. Regional transport and land use plans help to steer the city's development towards sustainability.

How it works and intended effects:

- Reduces urban sprawl.
  - ➔ Limits travel distances.
- Supports the accessibility of public transport.
  - ➔ Promotes a high share of public transport.

To be considered for implementation:

- The measure is relatively cheap, but sufficient institutional capacity is necessary at the different levels of cooperation.
- In rapidly developing cities, the measure has short-term effects (compared to car-oriented development); while in non-growing cities there are only long-term impacts (due to slow change of urban functions).
- The measure takes effect over time, but is hardly quantifiable in terms of emission mitigation.

Responsible actor: Local land use planning departments

GHG mitigation effect and co-benefits

Research has shown that smart land use has several positive effects on urban travel activity and energy consumption from transport (IEA, 2009):

- Reduction of per capita vehicle kilometres by 1 to 3 % per 10 % increase in urban density;
- Transit-oriented settlement structures reduce vehicle ownership and travel distances by 10 to 30 % and more than double the use of alternative modes compared to car-oriented settlements;
- Mixed land use can reduce the vehicle kilometres per resident by 5 to 15 %.

Based on these empirical findings, Dierkes *et al.,* (2005) assumes that compared to standard greenfield development, TOD can reduce vehicle kilometres travelled by 21 % compared to standard development. In their fictive example, vehicle kilometres were reduced by approximately 8 000 km leading to annual CO_2 emission mitigations of 717 tonnes and to annual fuel savings of 276 000 litres.

The city of San Carlos in California included different smart land use planning measures in their climate action plan, which intends to reduce the City's GHG emissions by 15 % till 2020 and by 35 % till 2030. In 2005, this city with 30,000 inhabitants emitted approximately 270 000 tonnes of CO_2-equivalent (CO_2e) and the emissions are projected to increase to 370 000 tonnes of CO_2e till 2030 if no measures are taken (baseline scenario). Transport accounts for more than half of these emissions. Among others, the following land use measures were selected to reduce the city's GHG emissions:

- High density and mixed-use development is estimated to reduce the city's emissions by 5 500 tonnes of CO_2e compared to the baseline scenario by 2030, if half of all new developments follow these principles. The costs per tonne of CO_2e were estimated at USD 0.81–1.62, since the only direct costs arise from the institutional capacity needed to revise municipal codes.
- Increased housing density near public transport routes is estimated to reduce the emissions by 5 000 tonnes of CO_2e, assuming that half of the housing development will be transit-oriented. Accounting for the costs of land use code revision, the costs per tonne of CO_2e are estimated to range between USD 4.50 and USD 10 (City of San Carlos Planning Department, 2009).

Besides reduced GHG emissions and lower energy consumption, smart land use planning can realise several co-benefits:

- More cost-effective operation of the public transport system;
- Less transport costs for individual households;
- Reduction in public expenditures for infrastructure construction and maintenance;
- Increased property values close to public transport stations;
- Reduced congestion;
- Attraction of businesses to high-density and accessible sites.

Towards implementation

The measure targets local businesses as well as the real estate industry and individual households. The selection of a business location influences the mobility behaviour of employees and business partners. Furthermore, measures to increase urban density and TOD require investments from the real estate industry in the selected corridors.

Key stakeholders

- Local land use planning departments:
  Responsible for municipal planning codes and the formulation of new urban development plans including new settlements and existing structures; can ensure that the settlement structures are designed or altered in a way that enables mobility based on low-carbon modes.

Table 2: Potential barriers to implementation and countermeasures

Barriers	Options to overcome
Lack of financial resources to extend the public transport infrastructure for TOD.	■ Joint development: cooperation between public authorities and private public transport operators to develop new settlement structures with public transport lines. The city sells or leases the development rights around public transport stations to the public transport operator, which can be used to expand the public transport network (Broaddus *et al.,* 2010).
Existence of land use and building codes that make it difficult for smart land use plans to obtain approval.	■ Comprehensive revision of the municipal land use and building codes (*e.g.* alter parking requirements, height and density limitations).
Market pressure towards low-density and low-cost, space-consuming settlement structures.	■ Involve the public and stakeholders to back decisions of planners against different interest groups (Petersen, 2004).
Public concerns that the measure drives social segregation and discrimination of low-income households that cannot afford dwellings close to public transport stations.	■ Set a minimum for social housing in the overall housing capacity close to the public transport station.

Curitiba, Brazil – Photo by Menckhoff, GIZ Photo Collection 2011

Success factors are

- Boundaries which limit suburban developments (could be either political, geographical or topographical);
- Sufficient institutional capacity to develop and implement smart land use plans;
- Close cooperation between land use and transport planning
- Strict enforcement of land use codes (inhibit illegal settlement structure at the outskirts of the city);
- Provide sufficient public transport capacity.

Practical example: Urban master plan in Curitiba

In 1960, the local government of Curitiba — the seventh largest city in Brazil with 1.8 million inhabitants — adopted an urban master plan with a special focus on an ecological urban structure. The plan integrated transport with land use planning: commercial growth was encouraged along the arteries radiating out from the city centre — while limiting central area growth. Also, land within two blocks of the public transport arteries was reserved for high-density development. New retail growth was channelled to public transport stops. Today, Curitiba is a good example of sustainable urban development in developing countries. Its transport fuel use per capita is about 30 % lower than in comparable Brazilian cities (Bongardt *et al.,* 2010).

Further reading

- **Bongardt, D., Breithaupt, M., and Creutzig, F. (2010)** '*Beyond the fossil city: Towards low carbon transport and green growth*', Technical Document, Sustainable Urban Transport Project (SUTP), GIZ, Eschborn, Germany.
- **Broaddus, A., Litman, T. and Menon, G. (2010)** '*Transportation Demand Management*', Training Document, Sustainable Urban Transport Project (SUTP), GIZ, Eschborn, Germany.
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- **Dierkes, G., Silsbe, E., Stott, S. Winkelman, S. and Wubben, M. (2005)** '*CCAP transportation emission guidebook – part one: land use, transit & travel demand management*', Centre for Clean Air Policy, Washington, Available at: http://www.ccap.org/safe/guidebook/guide_complete.html, accessed 8 December 2011.
- **IEA – International Energy Agency (2009)** Transport Energy and CO_2 – Moving toward sustainability, IEA, Paris
- **Norman, J., MacLean, H.L, Kennedy, C.A. (2006)** '*Comparing High and Low Residential Density: Life-Cycle Analysis of Energy Use and Greenhouse Gas Emissions*' Journal of Urban Planning and Development doi: 10.1061/(ASCE)0733-9488(2006)132:1(10).
- **Petersen, R. (2004)** '*Land use planning and urban transport*', Sourcebook Module 2a, Sustainable Urban Transport Project (SUTP), GIZ, Eschborn, Germany.

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