A GENERIC METHODOLOGY

for Economically Describing a City and its Agglomeration

to Reveal Energy Dependence and Contribution to Carbon Impact

Detailed Framework with Normalization to One Euro Base Unit and IPCC-Aligned Carbon Index

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1. Purpose and Scope

This document describes a generic, transferable methodology for economically describing any city and its agglomeration in a way that systematically reveals its energy dependence and the contribution of that dependence to greenhouse-gas (carbon) impact. The method is designed to be applied to any territorial authority or functional urban area, independent of national currency or institutional structure.

The framework starts from basic territorial metrics (surface area, population, density), assembles three layers of economic activity expressed in the local currency, normalizes the local public layer to a single unit of “one euro”, scales the other two layers to the same base, breaks each layer into sub-categories with explicit energy lines, and finally estimates carbon-dioxide-equivalent (CO_2e) impact according to IPCC emission-factor principles, producing a per-inhabitant carbon index.

2. Preamble Territorial Metrics

Every application of the method begins with three fundamental descriptors of the agglomeration:

- **Surface area (km²)** – administrative or functional urban area extent.
- **Population** – usually resident population of the same territory.
- **Density (inhabitants per km²)** – derived indicator that contextualises energy intensity and service delivery costs.

These three figures form the physical frame against which all subsequent economic and carbon metrics are interpreted.

3. The Three Economic Layers (in Real Local Currency)

Three complementary flows of money are quantified for the same territory and the same time period (normally one financial year):

3.1 Layer (1) – Local Public Capital (Local Taxes Reinvested Locally)

This is the revenue raised by the local territorial authority through rates, property taxes or equivalent local levies, and subsequently spent on local services and infrastructure. It represents the autonomous fiscal capacity of the city/agglomeration. Typical sub-categories include roads, water and wastewater, solid waste, parks, libraries, stormwater, regulatory services, community partnerships, emergency management and flood protection.

3.2 Layer (2) – State (National / Central Government) Investment in the Agglomeration

Because national budgets are not usually published at city level, this layer is constructed as a population-proportional share of total core national government expenditure (or of identifiable major

programmes). It captures the resources that the central state allocates to health, education, social security, pensions, law and order, defence, national transport and other functions that benefit the inhabitants of the agglomeration.

3.3 Layer (3) – Private Household Expenditure within the Agglomeration

This layer aggregates the actual spending of resident households on housing (excluding energy), food, transport, recreation, private health, clothing, communications and residual categories. It is normally derived from official household expenditure surveys scaled to the population of the territory.

4. Normalization to a One-Euro Base Unit

Whatever the original local currency, Layer (1) is mathematically set equal to 1.00 euro (or any chosen unit). All figures in Layers (2) and (3) are then scaled by the identical conversion factor:

Scale factor = 1 / absolute value of Layer (1) in local currency

After scaling, Layer (1) = 1.00 euro, Layer (2) and Layer (3) appear as multiples of that unit. This normalization removes currency differences and allows direct comparison of the relative weight of local public, national public and private spending for any city.

5. Sub-Categorisation with Explicit Energy Lines

Each of the three scaled layers is further decomposed into functional sub-categories. Energy expenditure must appear as distinct lines so that energy dependence becomes visible:

- **Renewable electricity** (hydro, geothermal, wind, solar) – usually low carbon intensity.
- **Hydrocarbon energy** (natural gas, petrol, diesel, coal) – high carbon intensity.

Within Layer (1) energy may appear only indirectly (through infrastructure maintenance or emergency management). Within Layer (3) the split between renewable electricity and hydrocarbon fuels is critical. Layer (2) energy is largely embedded in national programmes and is rarely isolated at city scale.

6. Estimation of Carbon Impact (IPCC-Aligned)

Once the energy sub-categories are quantified in physical or monetary terms, standard IPCC emission factors (or national factors consistent with IPCC guidelines) are applied:

1. Convert energy volumes or expenditures into physical energy units (kWh, litres, MJ) where necessary.
2. Multiply by appropriate emission factors (g or kg CO_2e per unit) drawn from IPCC Assessment Reports or national inventory methods.
3. Sum the resulting CO_2e across all energy lines and any other high-impact categories that can be robustly estimated (e.g., certain food or construction activities).
4. Obtain total annual CO_2e attributable to the agglomeration under the chosen system boundary.

The final step is to divide total CO_2e by the population of the agglomeration, producing a per-inhabitant carbon index (tonnes CO_2e per capita per year). This index serves as a comparable metric of the carbon intensity of the city's economic activity and lifestyle.

7. Illustrative Application – New Plymouth District, New Zealand (2026/27)

The methodology is illustrated with data for New Plymouth District (Taranaki, New Zealand). All figures refer to the financial year 2026/27 or the nearest available official statistics.

7.1 Preamble Metrics

- Surface area: 2 205.59 km²
- Population (June 2025 estimate): approximately 90 100
- Density: approximately 40.9 inhabitants per km²

7.2 Three Layers in New Zealand Dollars

- **Layer (1) Local rates revenue:** approximately NZ$173 million
- **Layer (2) Proportional national expenditure:** approximately NZ$2.63 billion (1.7 % population share of core Crown expenses ≈ NZ$155 billion)
- **Layer (3) Private household expenditure:** approximately NZ$3.46 billion (scaled from national Household Expenditure Survey averages)

7.3 Normalization to One Euro

Setting Layer (1) = 1.00 euro yields the following scaled values:

- Layer (1) Local public = 1.00 euro
- Layer (2) National public ≈ 15.2 euro
- Layer (3) Private household ≈ 20.0 euro

7.4 Sub-Categories with Energy Visibility (Scaled Base)

Layer (1) – Local public (1.00 euro total)

Roads 0.18 · Wastewater 0.13 · Water 0.12 · Venues & Events 0.11 · Parks 0.09 · Solid Waste 0.07 · Puke Ariki & Libraries 0.06 · Stormwater 0.05 · Regulatory Services 0.05 · Community Partnerships 0.04 · Management of Investments 0.03 · Arts 0.02 · Governance Support 0.02 · Economic Development 0.02 · Emergency Management 0.01 · Flood Protection 0.00

Layer (2) – National public (≈15.2 euro total)

Health 3.30 · NZ Superannuation 2.55 · Social security & welfare 2.60 · Education 2.15 · Finance costs 1.00 · Law & order / Police & Justice 0.75 · Core government services 0.65 · Transport & communications 0.50 · Other (incl. Defence) 1.50

Layer (3) – Private household (20.00 euro total)

Housing (excluding energy) 7.50 · Food 3.50 · Hydrocarbon energy (gas + petrol/diesel) 2.50 · Clothing, communication, alcohol & other 1.70 · Transport (excluding fuel) 1.50 · Recreation & culture 1.50 · Renewable electricity (hydro/geothermal/wind/solar) 1.00 · Private health & insurance 0.80

7.5 Carbon Impact Estimation and Per-Capita Index

Applying IPCC-consistent emission factors to the visible energy lines (primarily the hydrocarbon component of Layer 3 and the national electricity mix) yields an indicative territorial carbon footprint. New Zealand's national average is approximately 15–17 tonnes CO_2e per capita per year (consumption-based estimates). The city-level index derived from the energy sub-categories above can be compared with this national benchmark to reveal relative energy dependence and carbon intensity of the agglomeration.

8. Sources (Full URLs)

All data and methodological principles used in this framework and in the New Plymouth illustration are drawn from publicly available official sources:

1. New Plymouth District Council – How NPDC Spends Each Dollar 2026/27: https://www.npdc.govt.nz/media/p25guaet/how-npdc-spends-each-dollar-2026-27.jpg
2. New Plymouth District Council – Rates information: https://www.npdc.govt.nz/home-and-property/rates-information/
3. The Treasury – Budget 2026 at a Glance: https://www.treasury.govt.nz/sites/default/files/2026-05/b26-at-a-glance.pdf
4. Stats NZ – Household Expenditure Statistics year ended June 2023: https://www.stats.govt.nz/information-releases/household-expenditure-statistics-year-ended-june-2023/
5. Stats NZ / Infometrics – New Plymouth District population estimates: https://www.npdc.govt.nz/council/about-the-council/who-we-are/district-statistics/
6. MBIE – Energy in New Zealand / Energy prices: https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-publications-and-technical-papers/energy-in-new-zealand/
7. IPCC – Assessment Report 6 (AR6) and emission-factor guidance: https://www.ipcc.ch/assessment-report/ar6/
8. Our World in Data – New Zealand CO_2 and Greenhouse Gas Emissions: https://ourworldindata.org/co2/country/new-zealand

9. Conclusion

The methodology presented here provides a transparent, reproducible and currency-independent way to describe the economic structure of any city and its agglomeration while making energy dependence and carbon impact visible. By anchoring all figures to a single local-public unit of one euro and by isolating renewable versus hydrocarbon energy lines, the framework enables both intra-city diagnosis and inter-city comparison. The final per-capita CO_2e index, calculated under IPCC-consistent rules, supplies a clear performance metric for policy discussion and climate action planning.

Document prepared for analytical and educational purposes. All figures for New Plymouth are illustrative and derived from publicly available official sources listed above.

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