



DECODING THE VECTOR OF ENERGY POVERTY

*Understanding the components of energy systems
in the urban-rural context of NCR, India*

Lakshmi Baiju | Master thesis presentation

Studio : Urban Metabolism | **First mentor:** Alexander Wandl | **Second mentor:** Nico Tillie



*Decoding Energy
Poverty*

*Research by
design*

*Vision &
strategies*

*Overview &
Conclusions*



Where would you live?





Energy is essential



“A little less than **1 billion people do not have any electricity** at home, and almost **2.7 billion people still use traditional fuels** like biomass for cooking”

-(IEA 2018)



“Energy poverty”

Energy Poverty

absence of sufficient choice

reliable, high-quality

environmentally benign



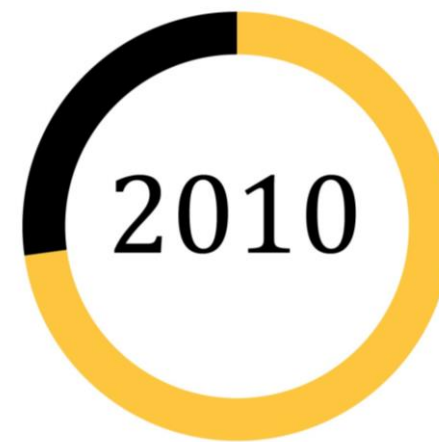
Energy Services

Lack of proper economic & human development

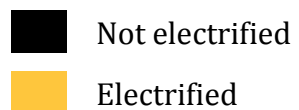
The Indian context

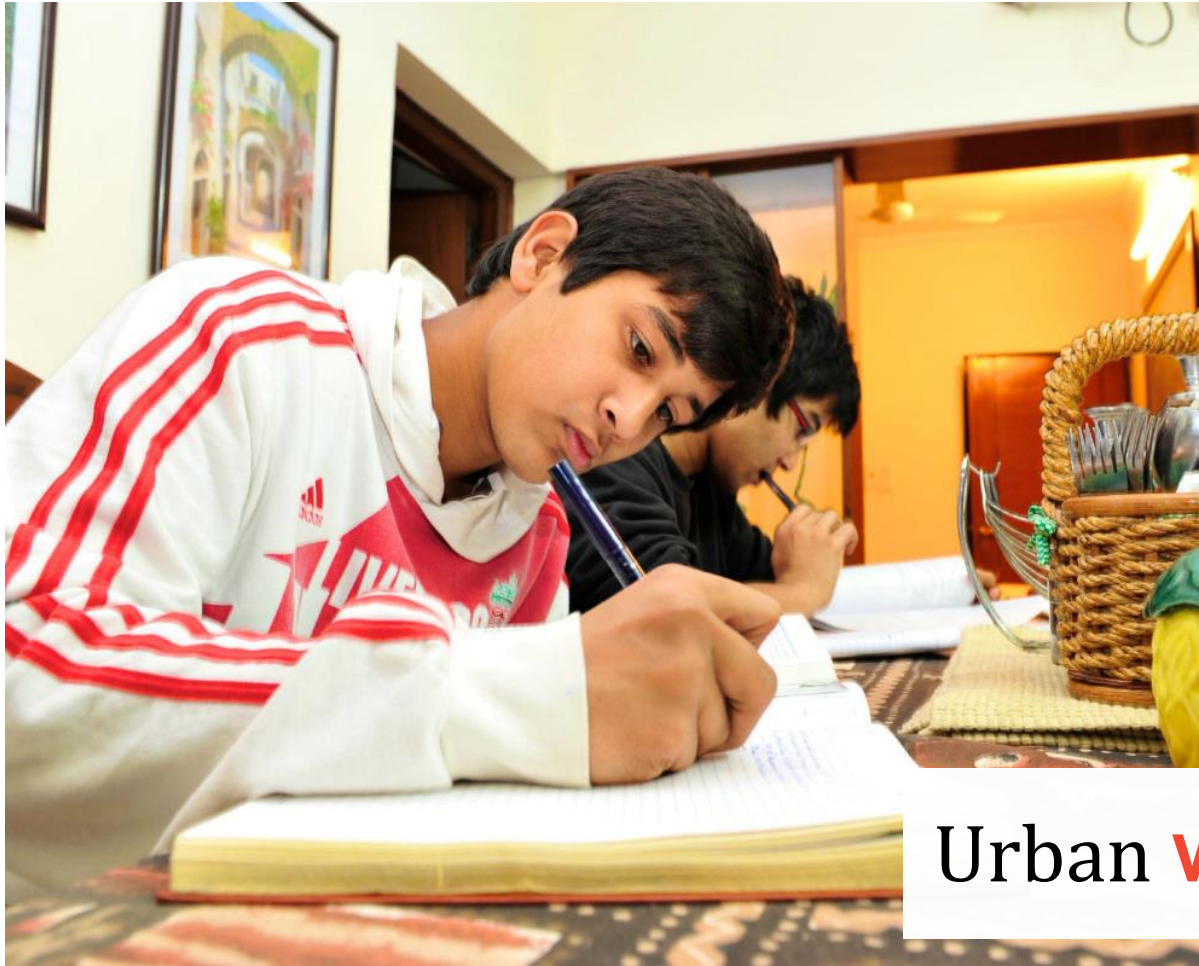


1% electrified villages



73% electrified villages





Urban **vs** Rural

Low standard of living

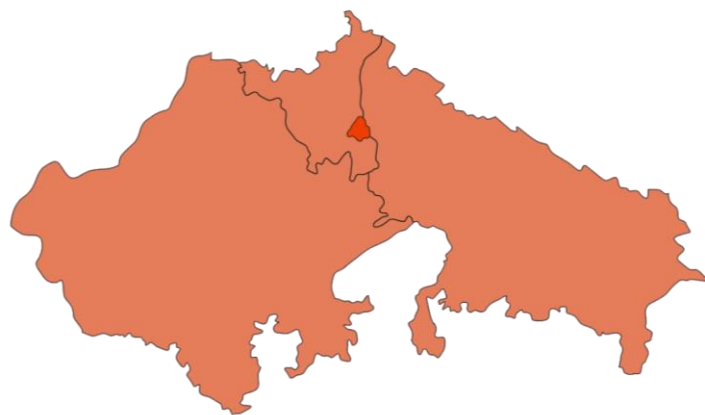
Indoor air pollution

Low agricultural production

Poor levels of education



National Capital Region

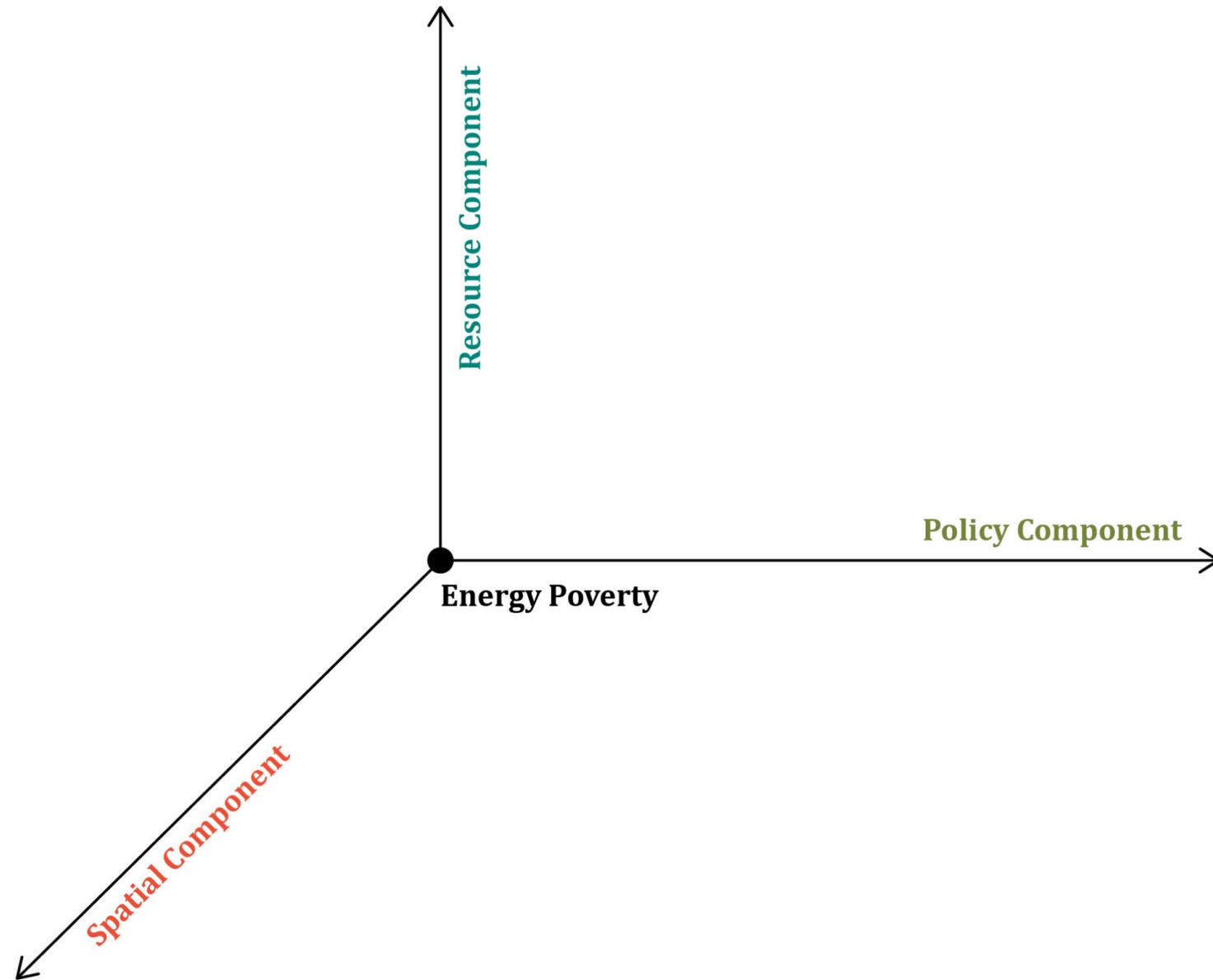


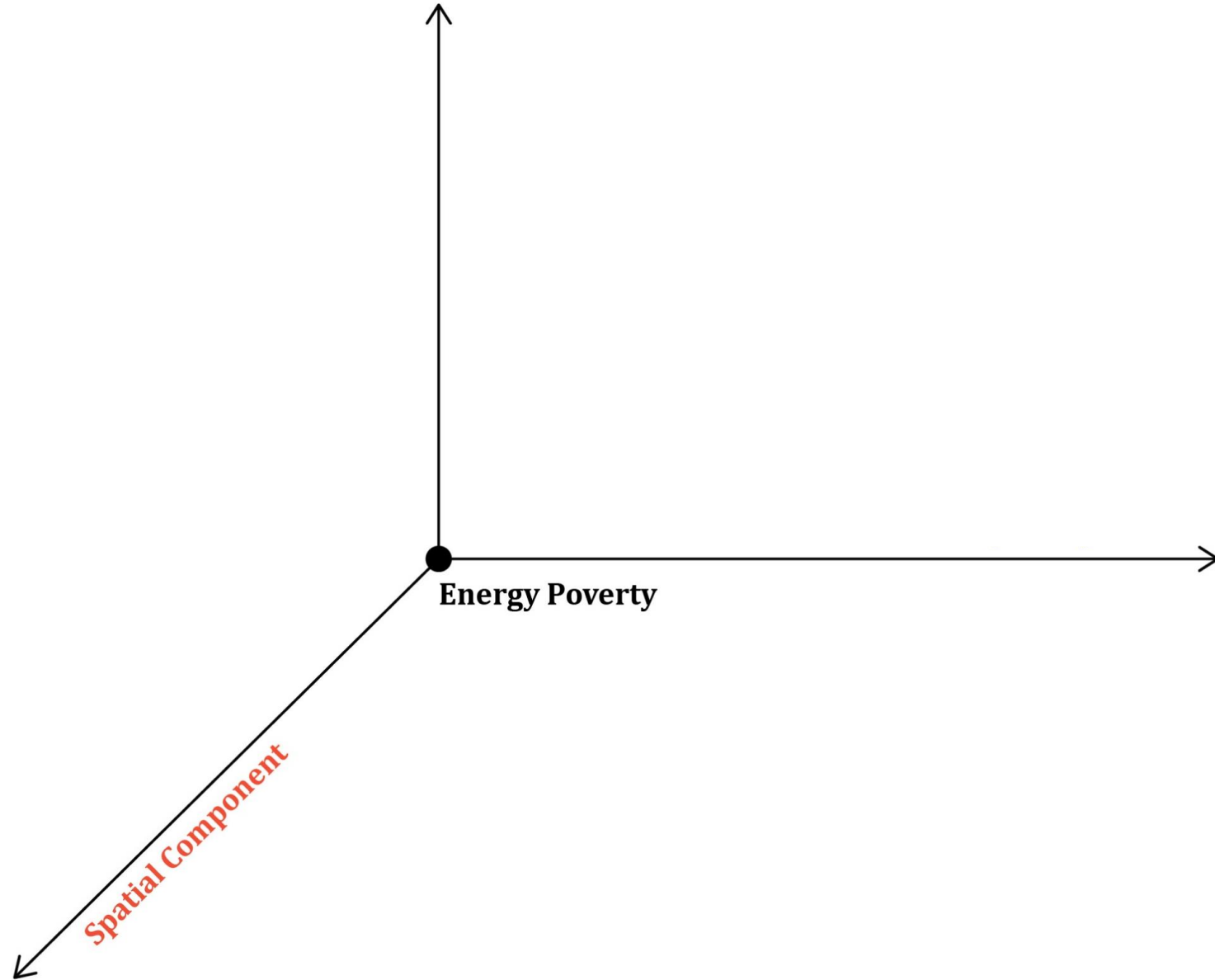
Delhi

Haryana

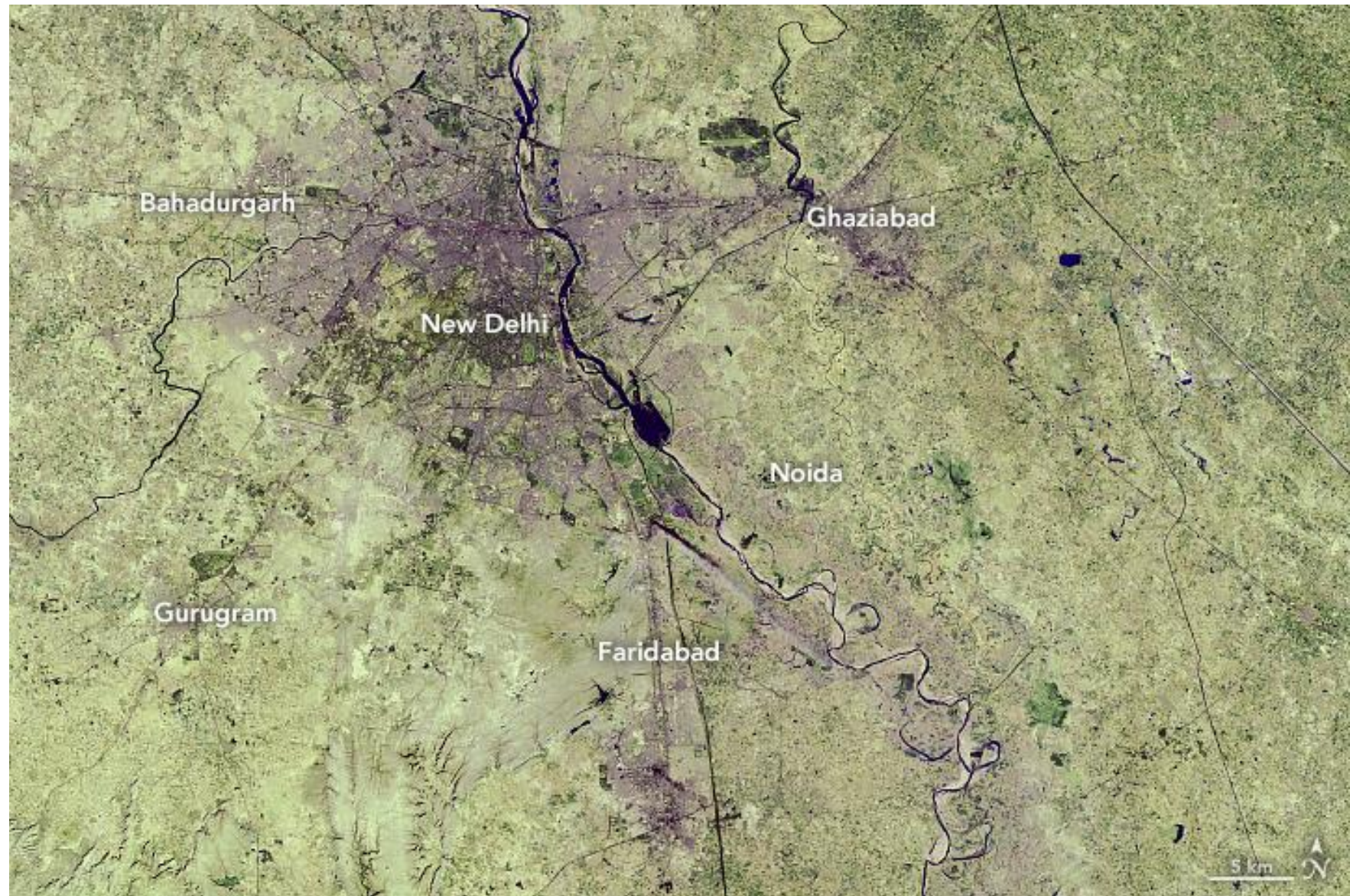
Uttar Pradesh

Rajasthan

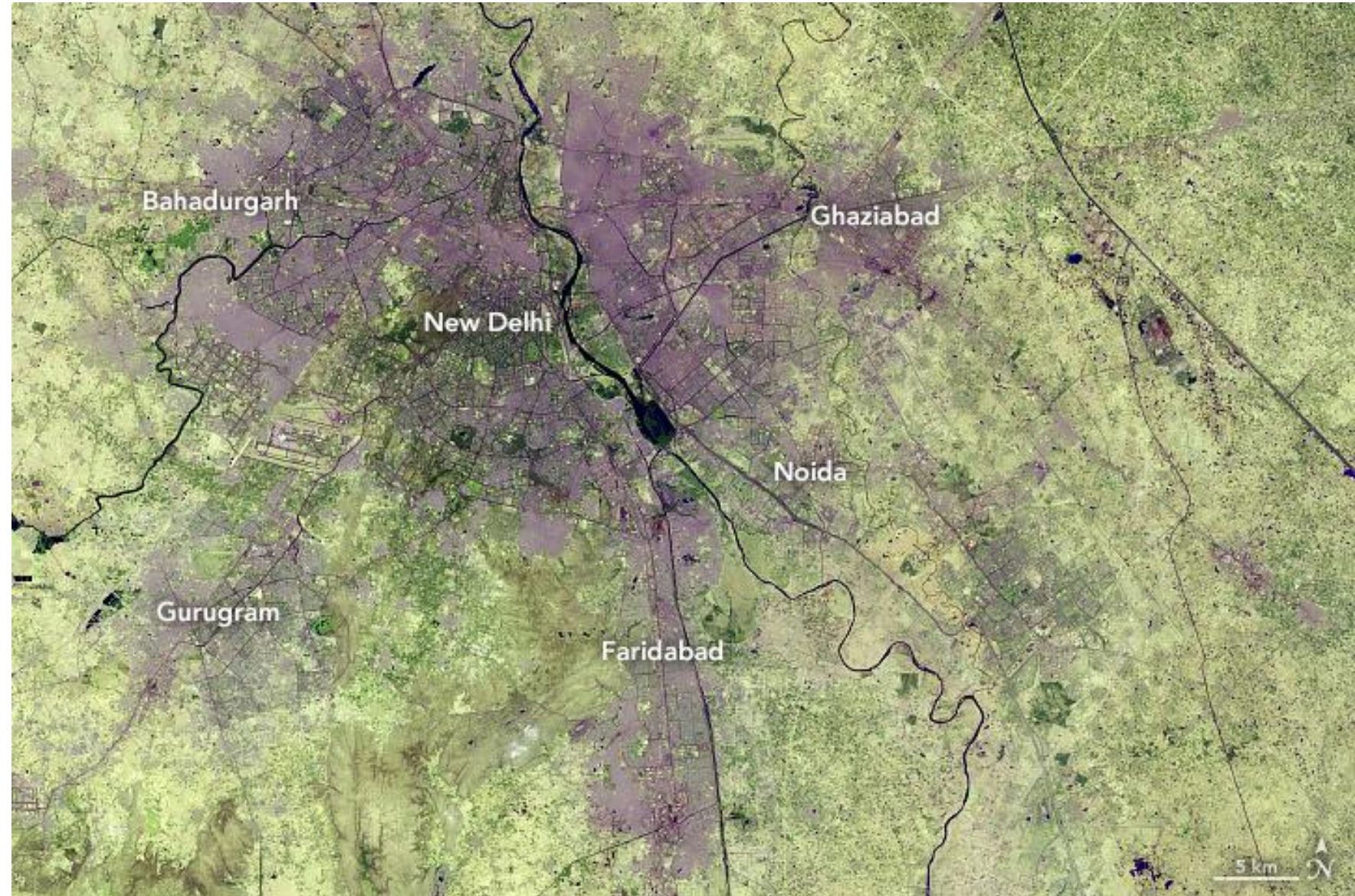




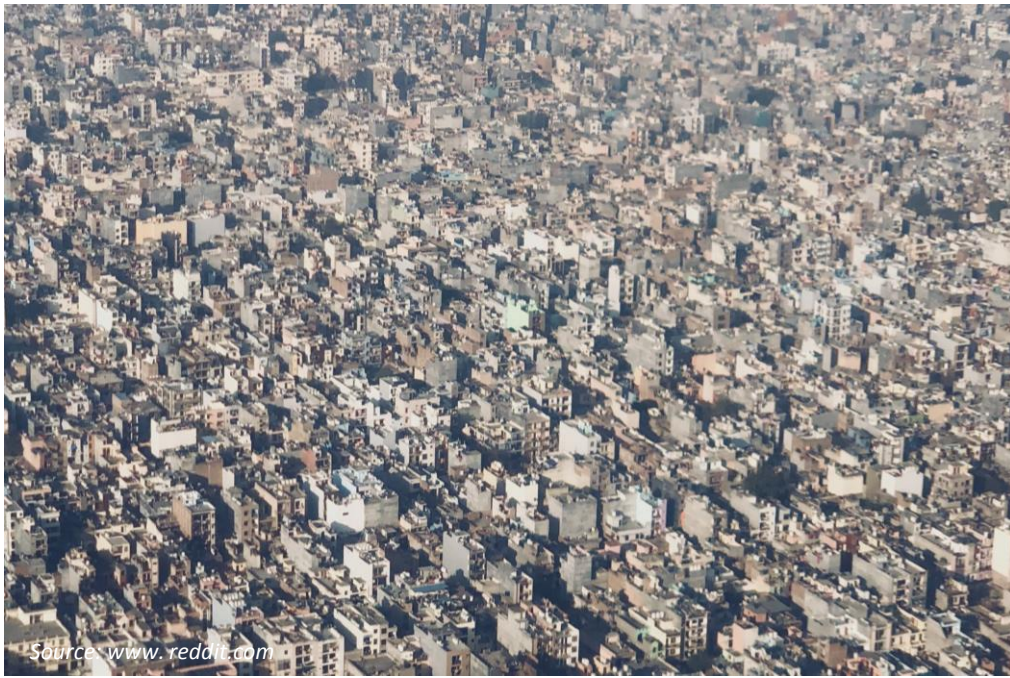
1989



2018



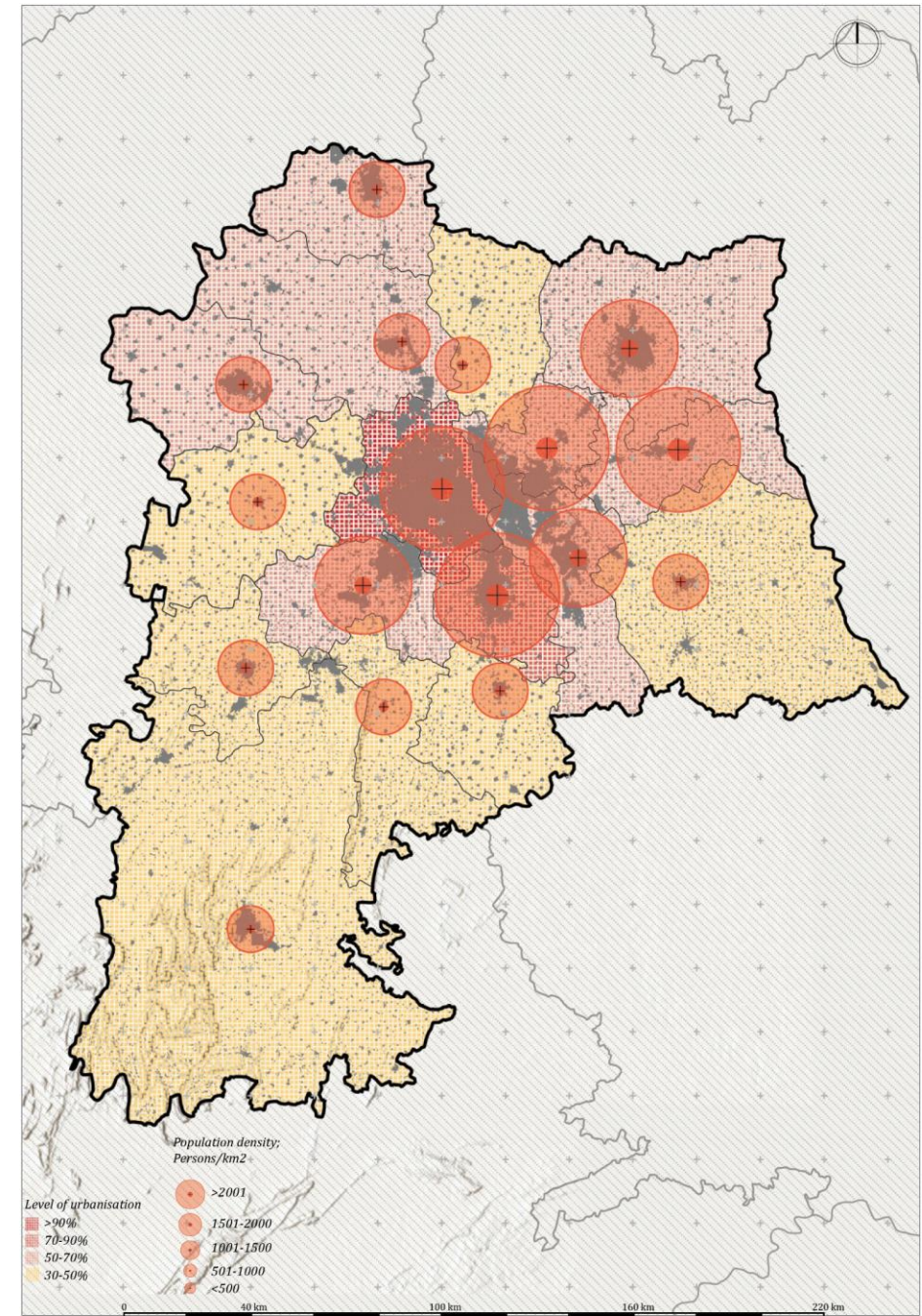
High levels of urbanisation



Low levels of urbanisation

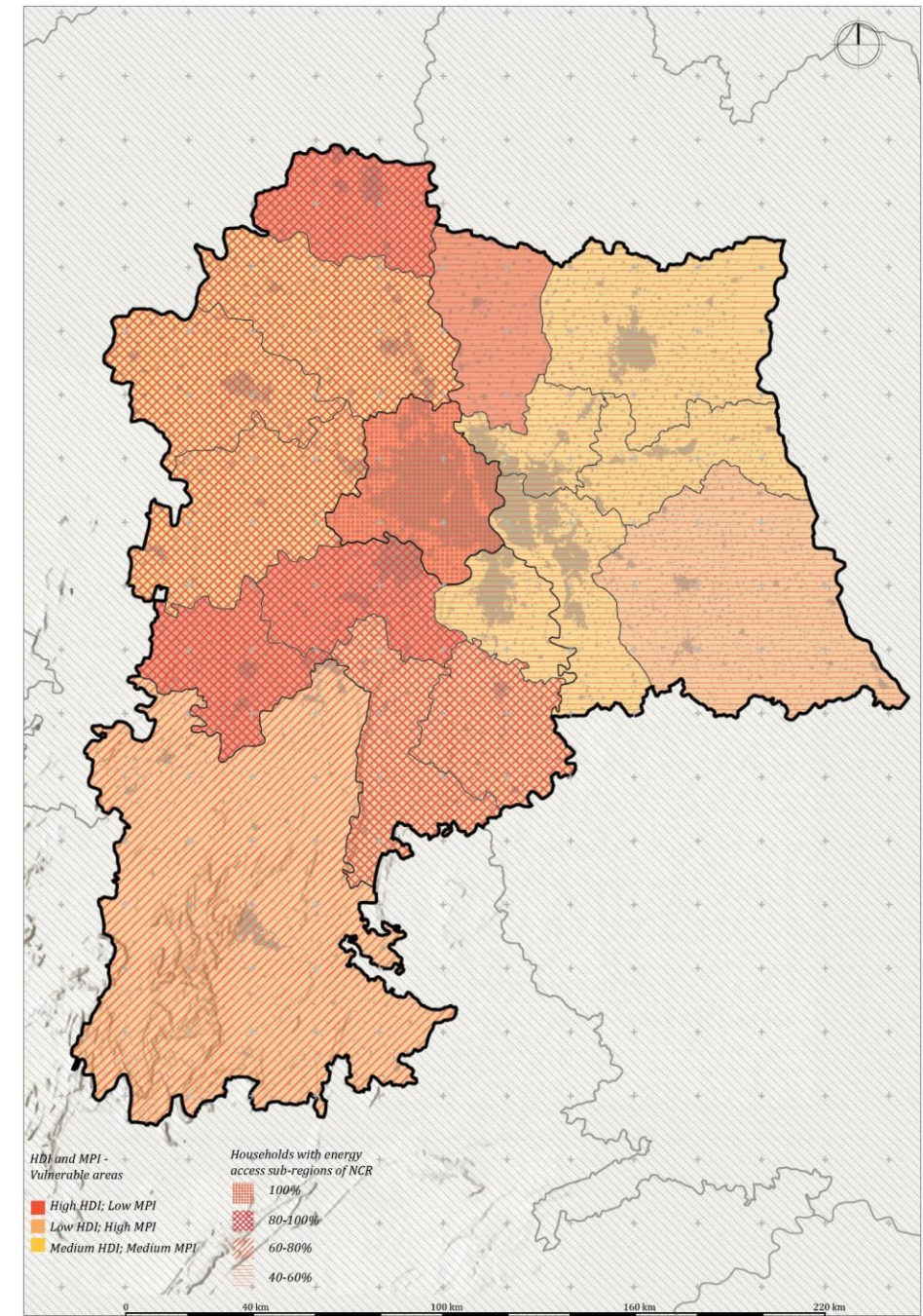


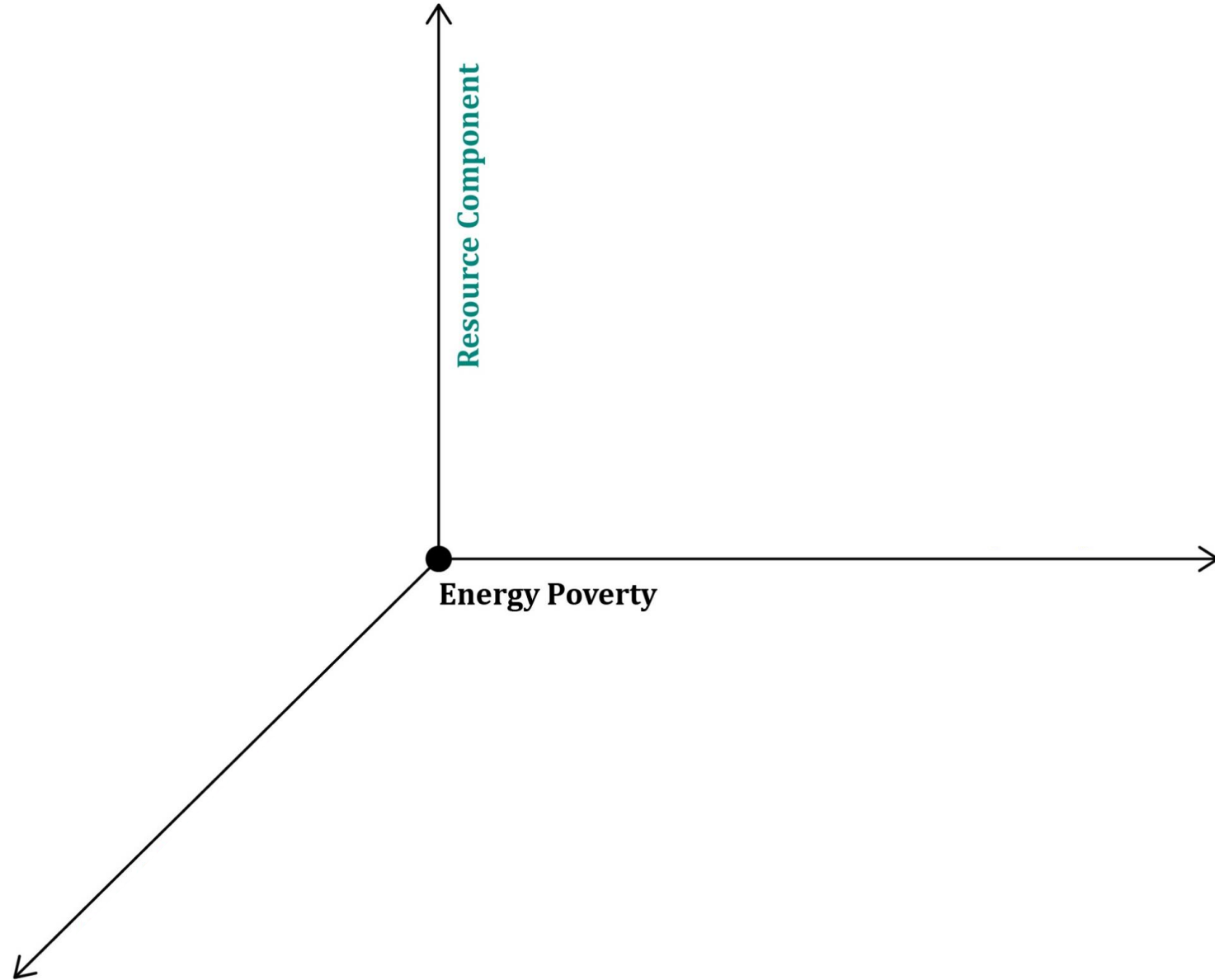
Level of Urbanisation





Source: Jayanti Chowdary,Public domain





Energy Flows

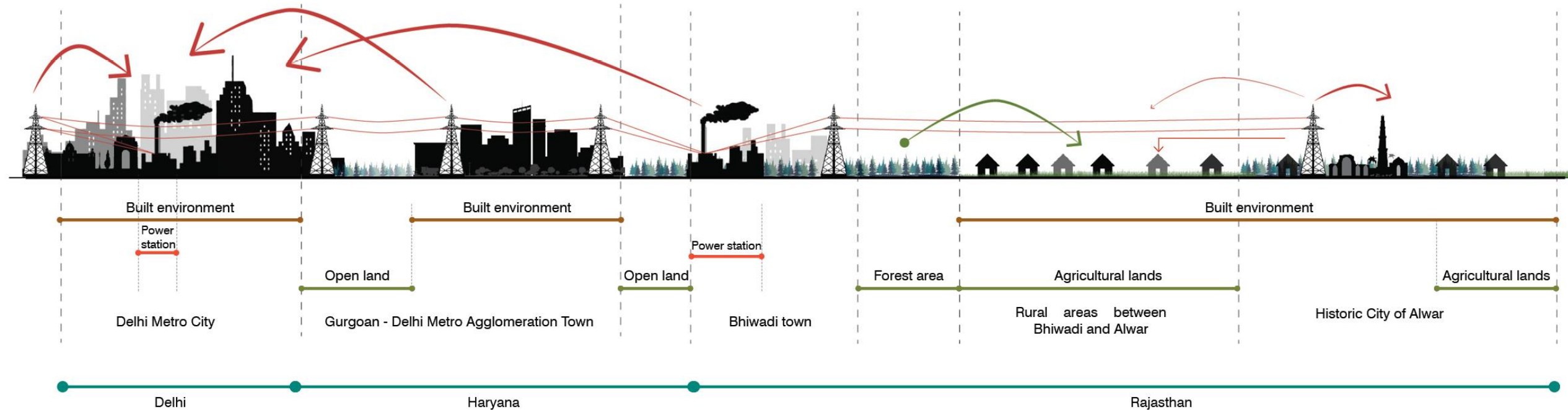
Power stations trying to meet the surplus demand in the cities; the Delhi region has 2 thermal power plants that supply electricity to the city.

Fumes from the power plants also add to the pollution levels in the region.

Wood is collected from the nearby forest areas to help make up for the lack of energy in the rural areas

Electricity available only for 2-3 hours a day

Priority given to meet city demands; however subjected to frequent power cuts





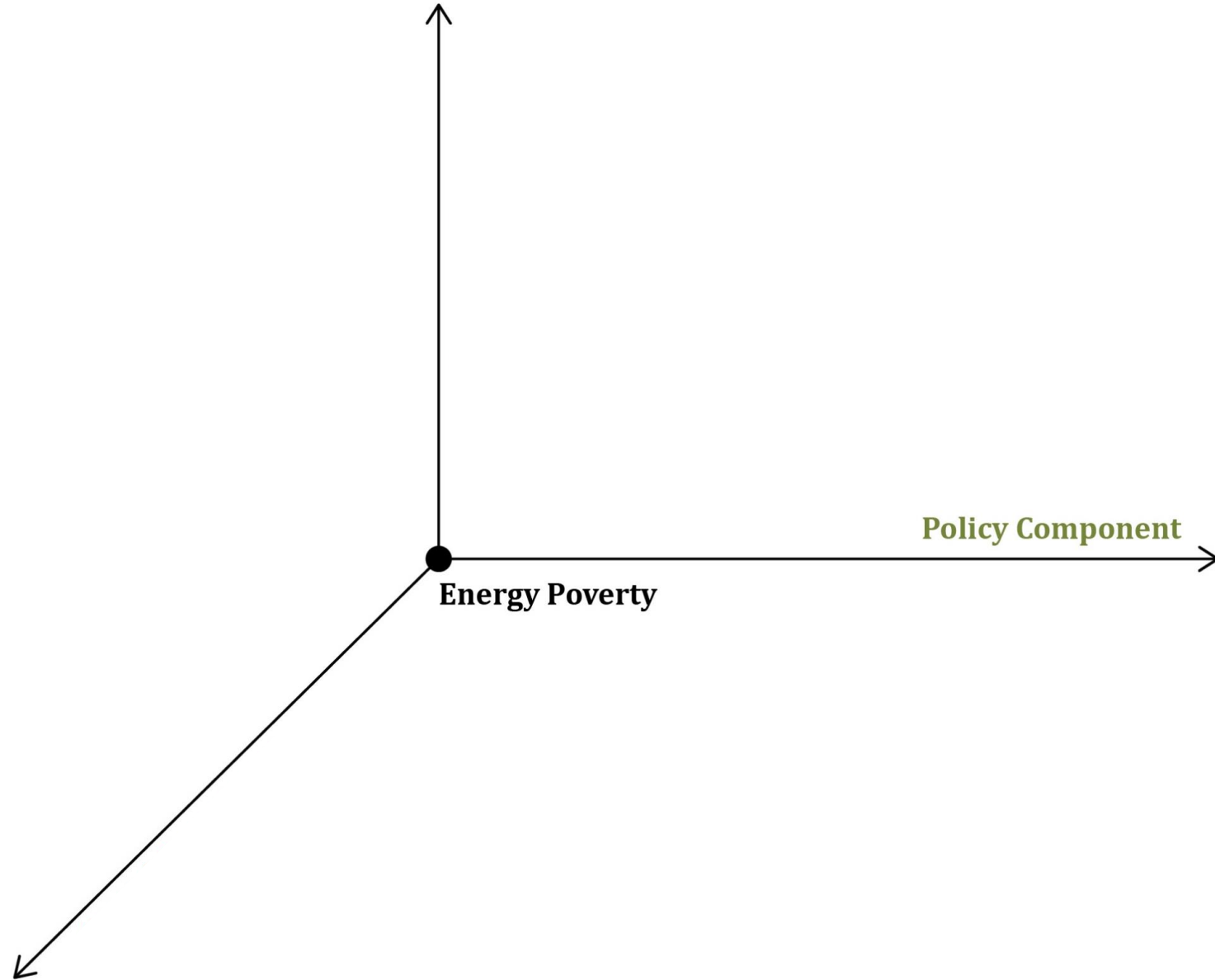
BEWARE DELHIITES: DELHI POLLUTION PLUNGES INTO VERY POOR CATEGORY, MORE BAD AIR DAYS AHEAD

October 17, 2019 11:54 AM | Skymet Weather Team



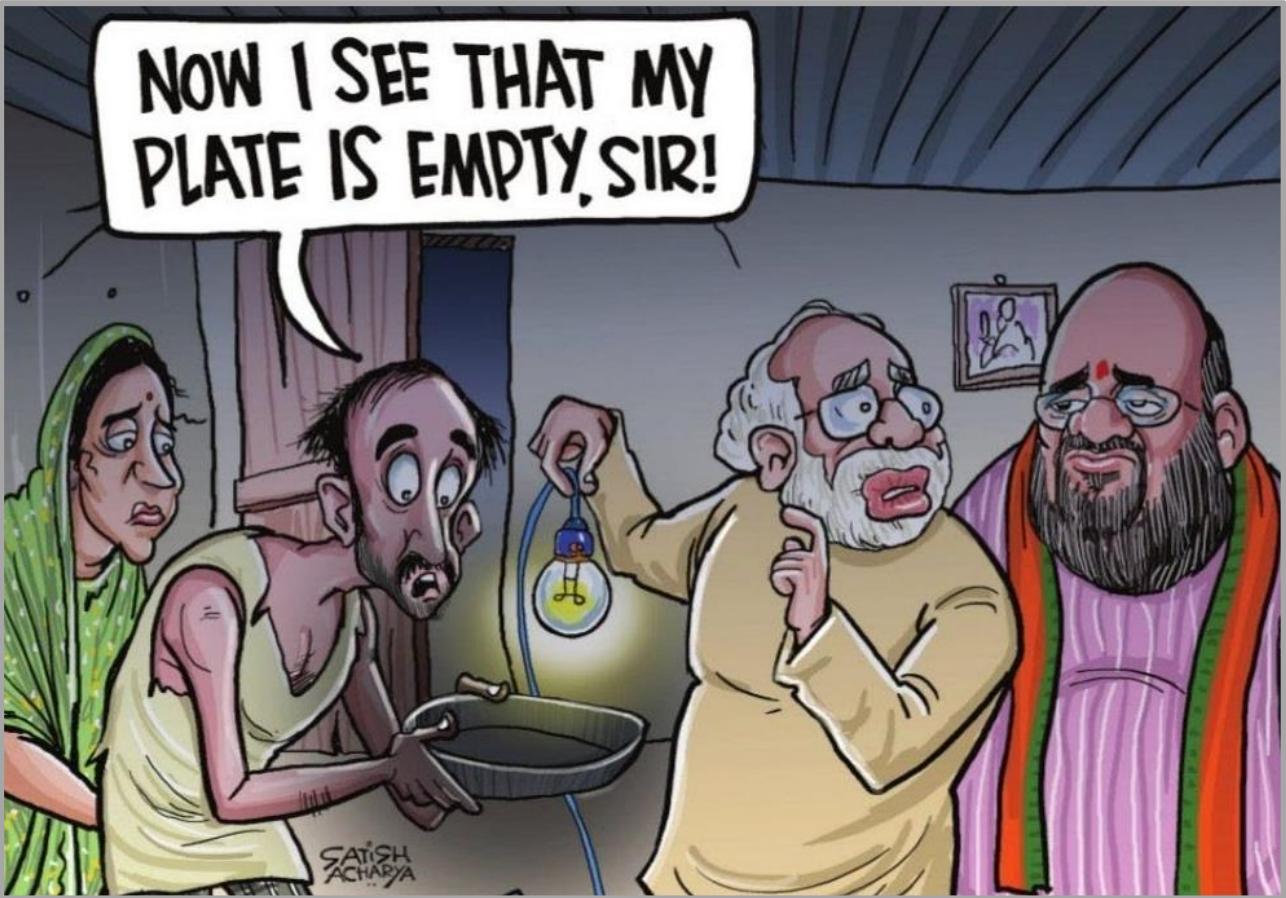
“ As, urban-rural systems are linked across sectors, space and time; the optimal use of environmental assets by the systems will principally determine their coping capacities..”

- (Sukhwani et al; 2019)

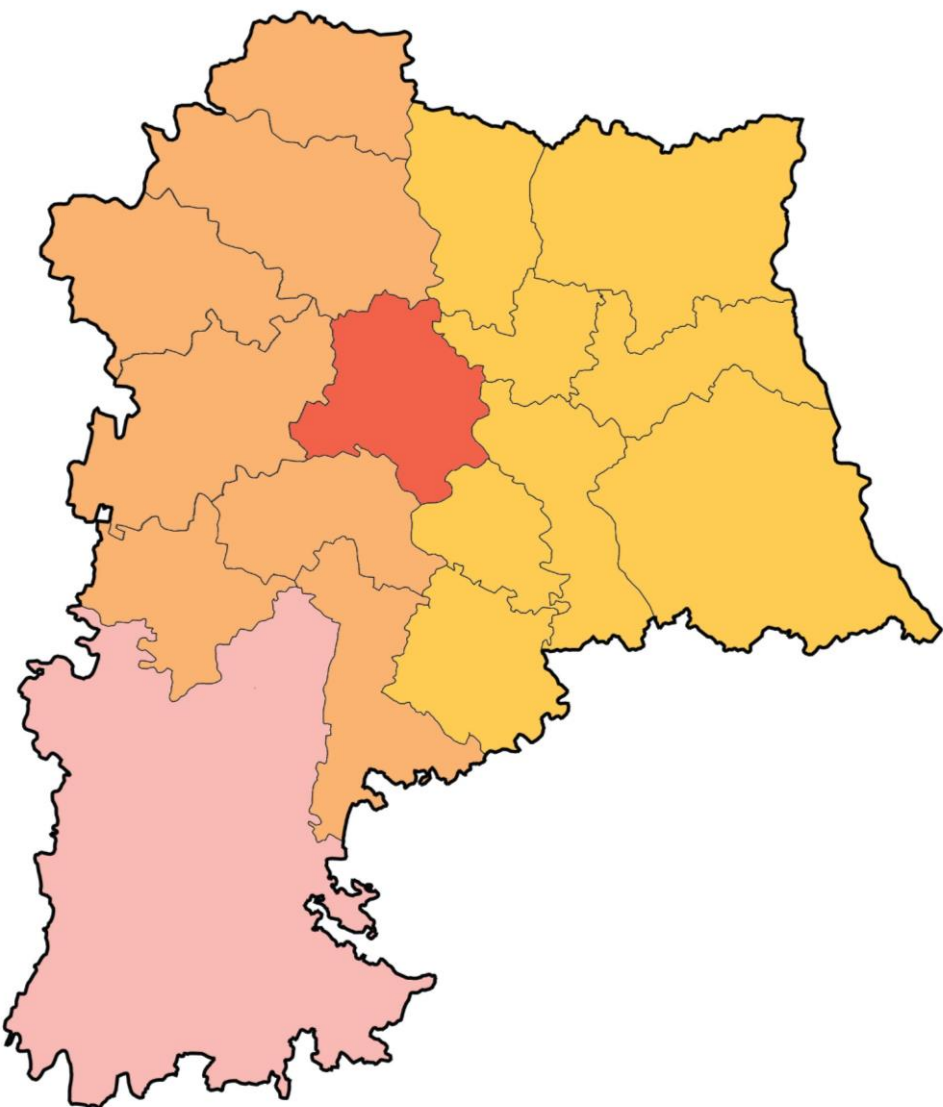




Source: www.firstpost.com



Source: www.mailtoday.com



Problem Focus

The **National Capital region of India**, is looking to negate energy poverty by merely extending existing energy networks. However, as city hubs continue grow and consume large amount of energy resources, **the urban-rural system suffer in terms of energy injustice**. This issue is over laid with poor attempts to address energy poverty that pay little attention to **the growing urban-rural divide**, the **need for clean energy transition** and the **pressure caused on the FEW nexus**.

**How can a regional energy system between urban and rural areas be designed
for a just renewable energy transition in NCR, India ?**

socially fair

environmentally sound

economically viable

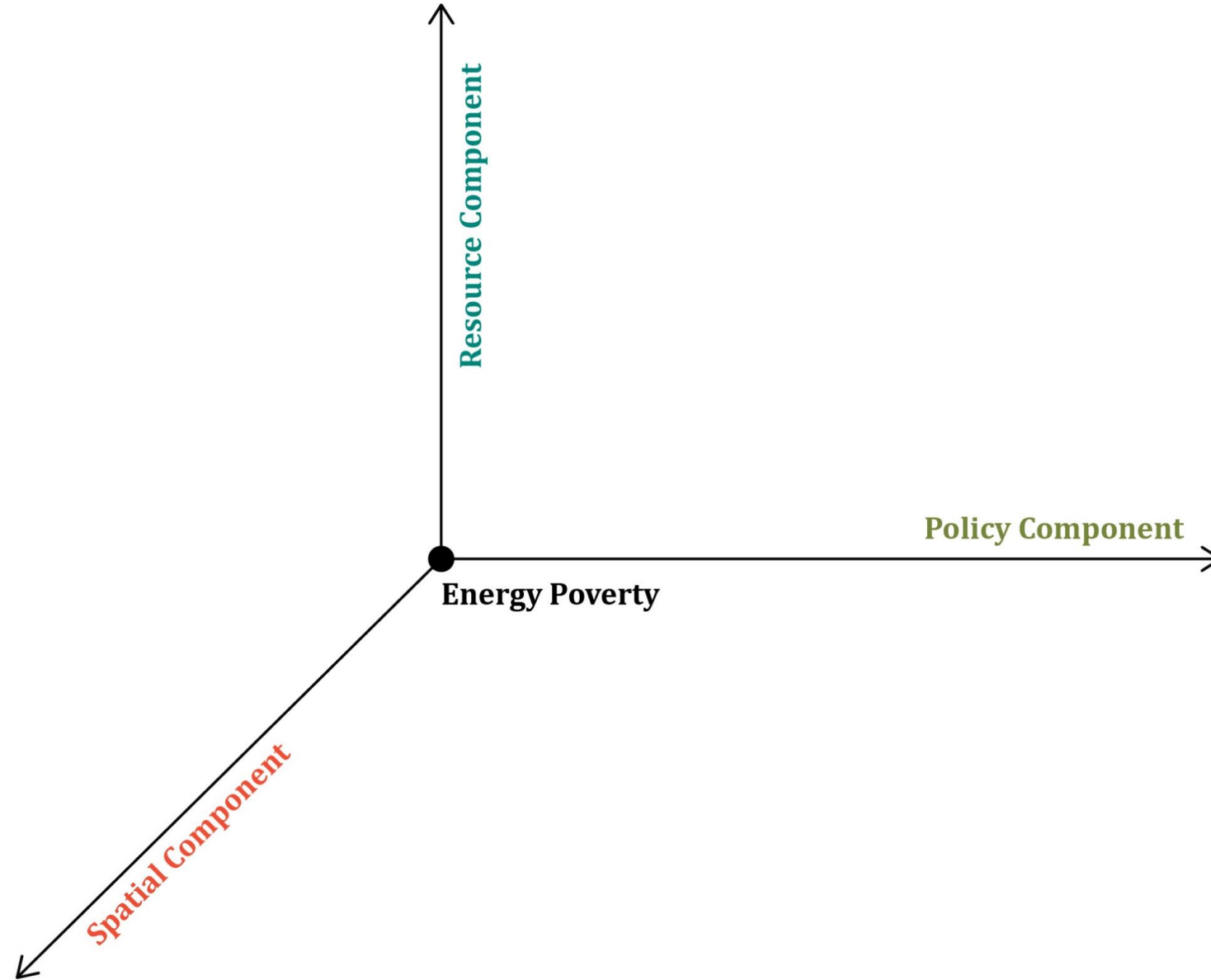
sustainable

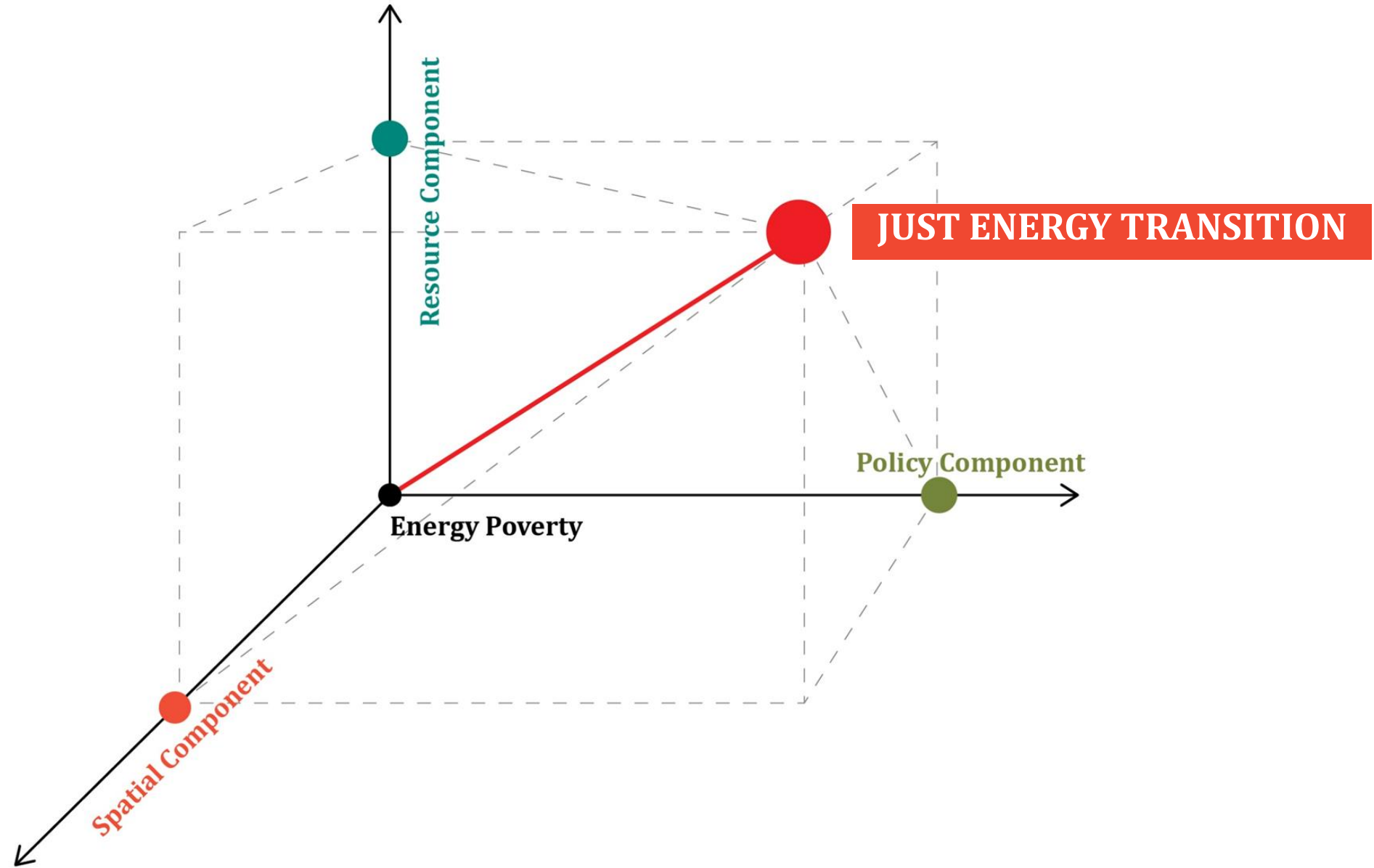
How can a regional energy system between urban and rural areas be designed
for a **just** renewable energy transition in NCR, India ?

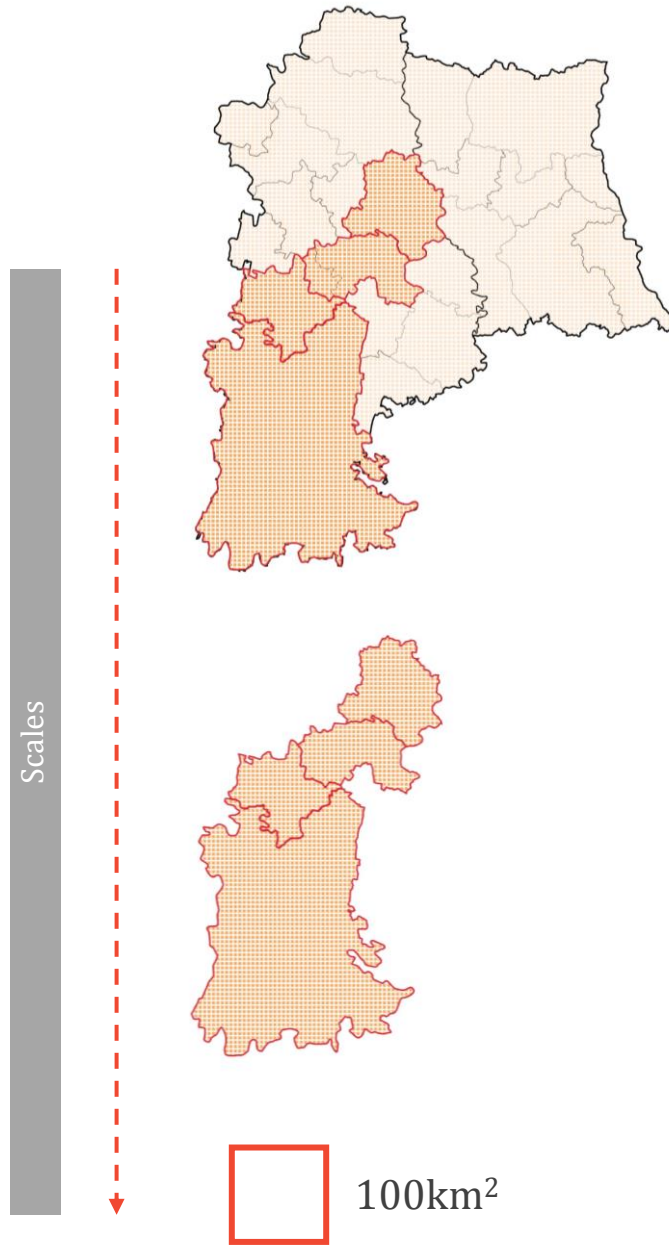
Social

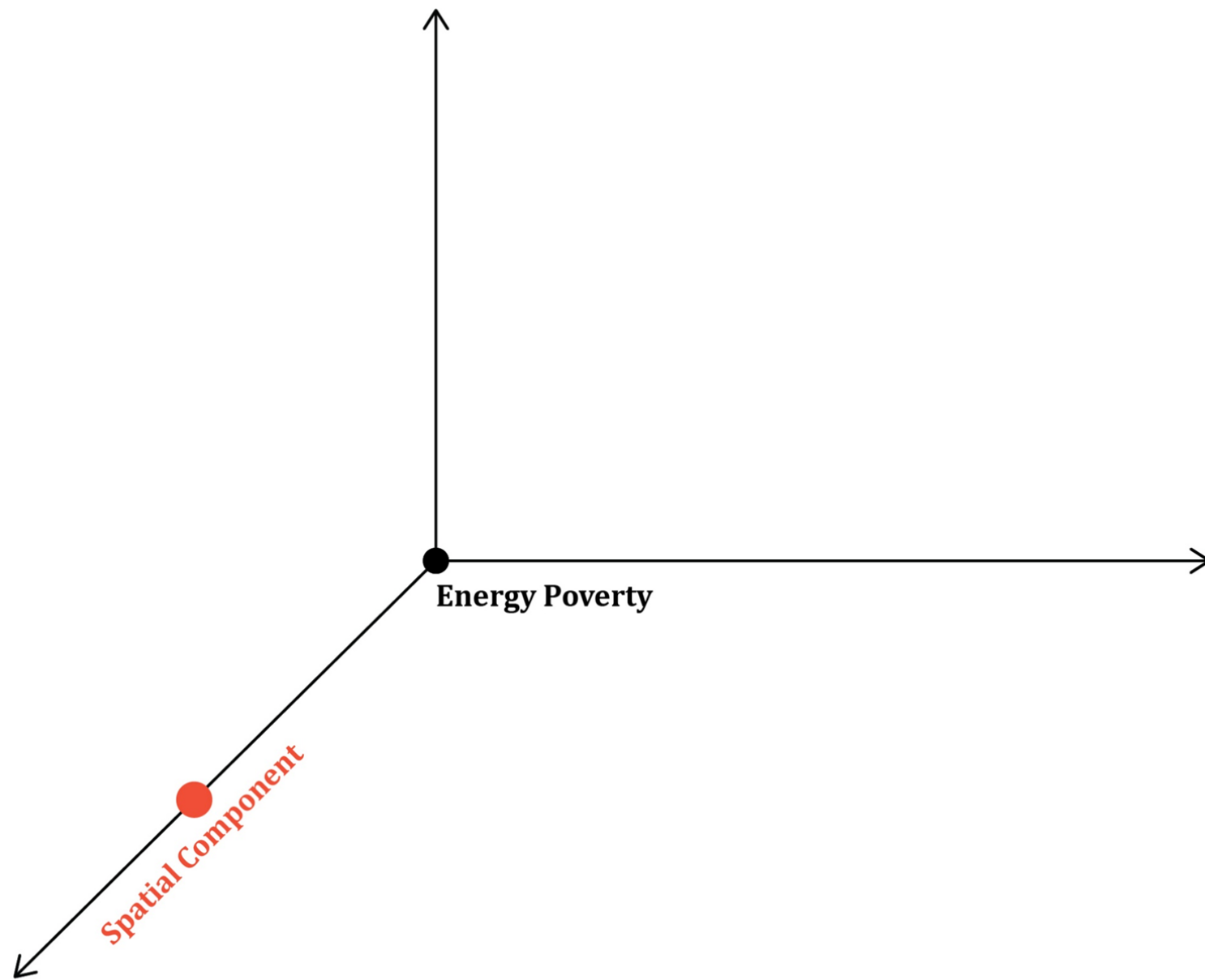
Ecological

Economic

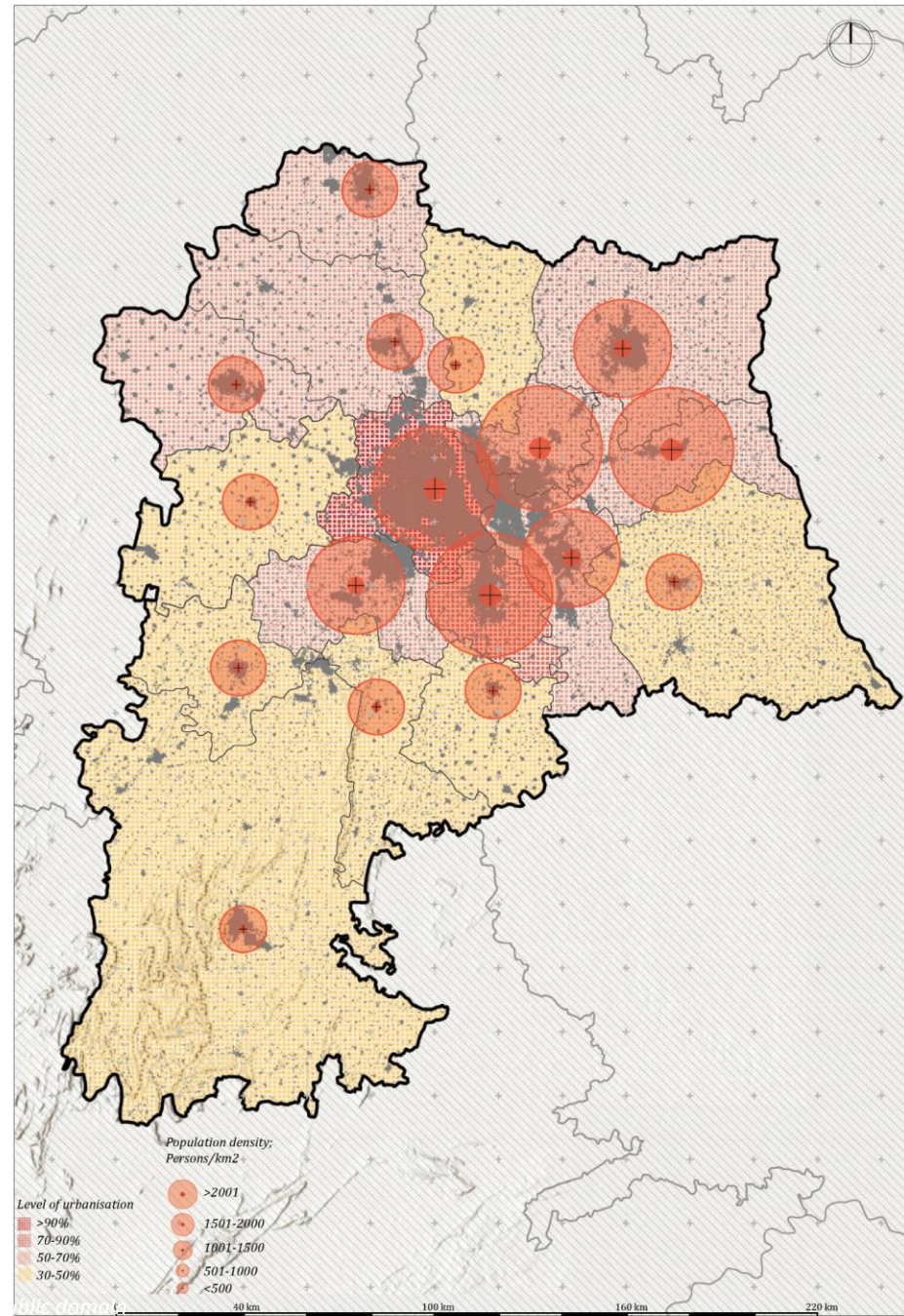




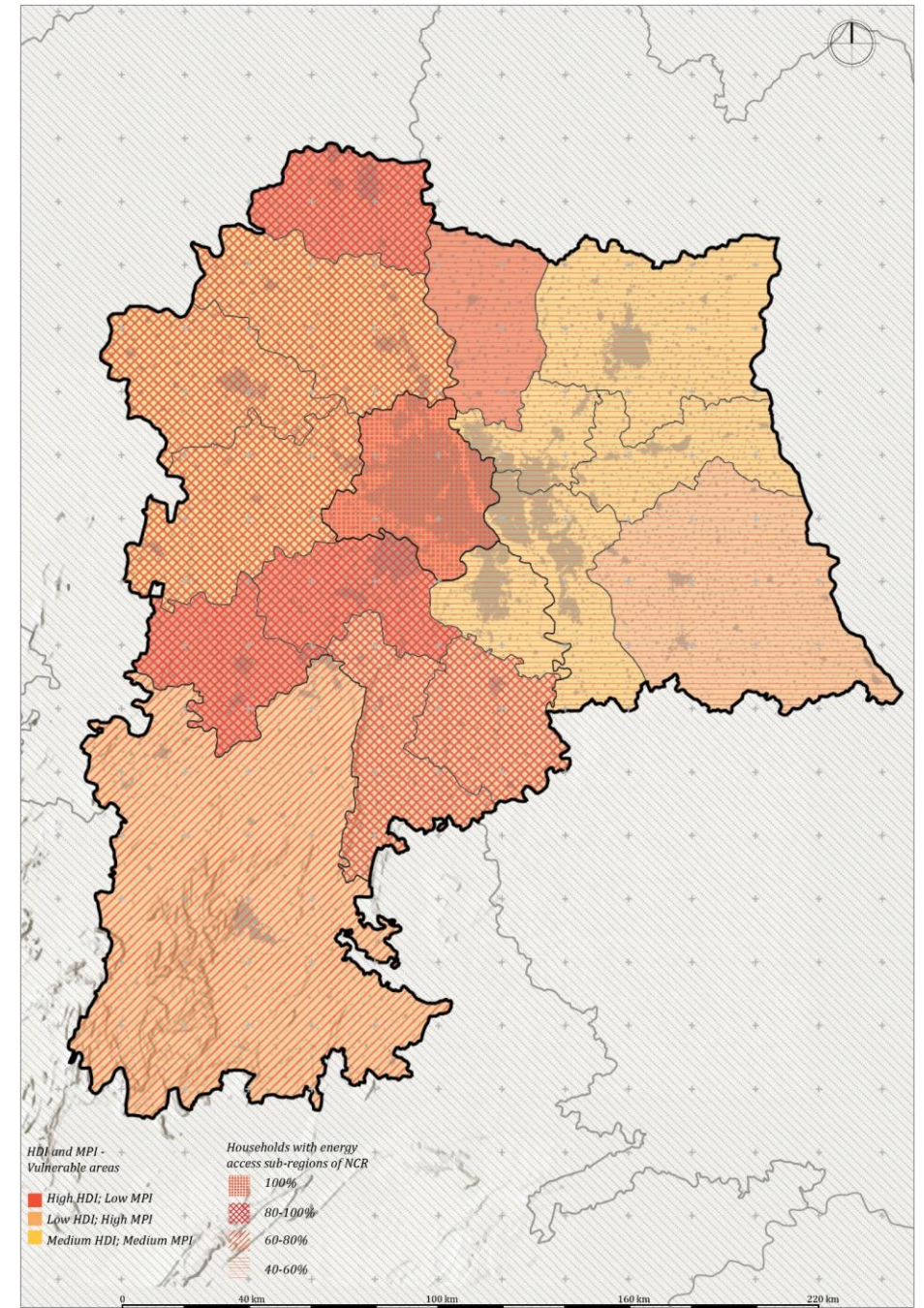


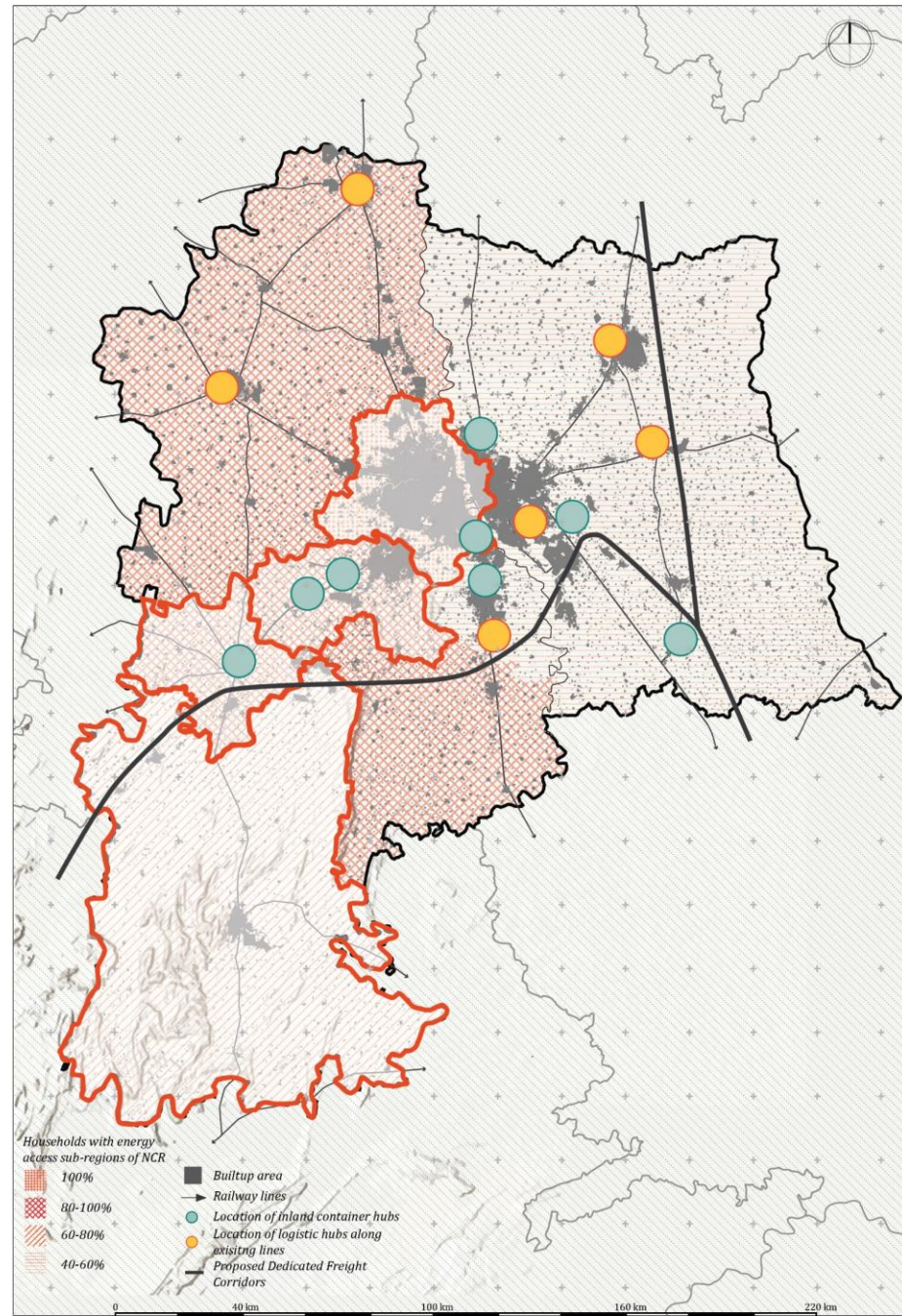


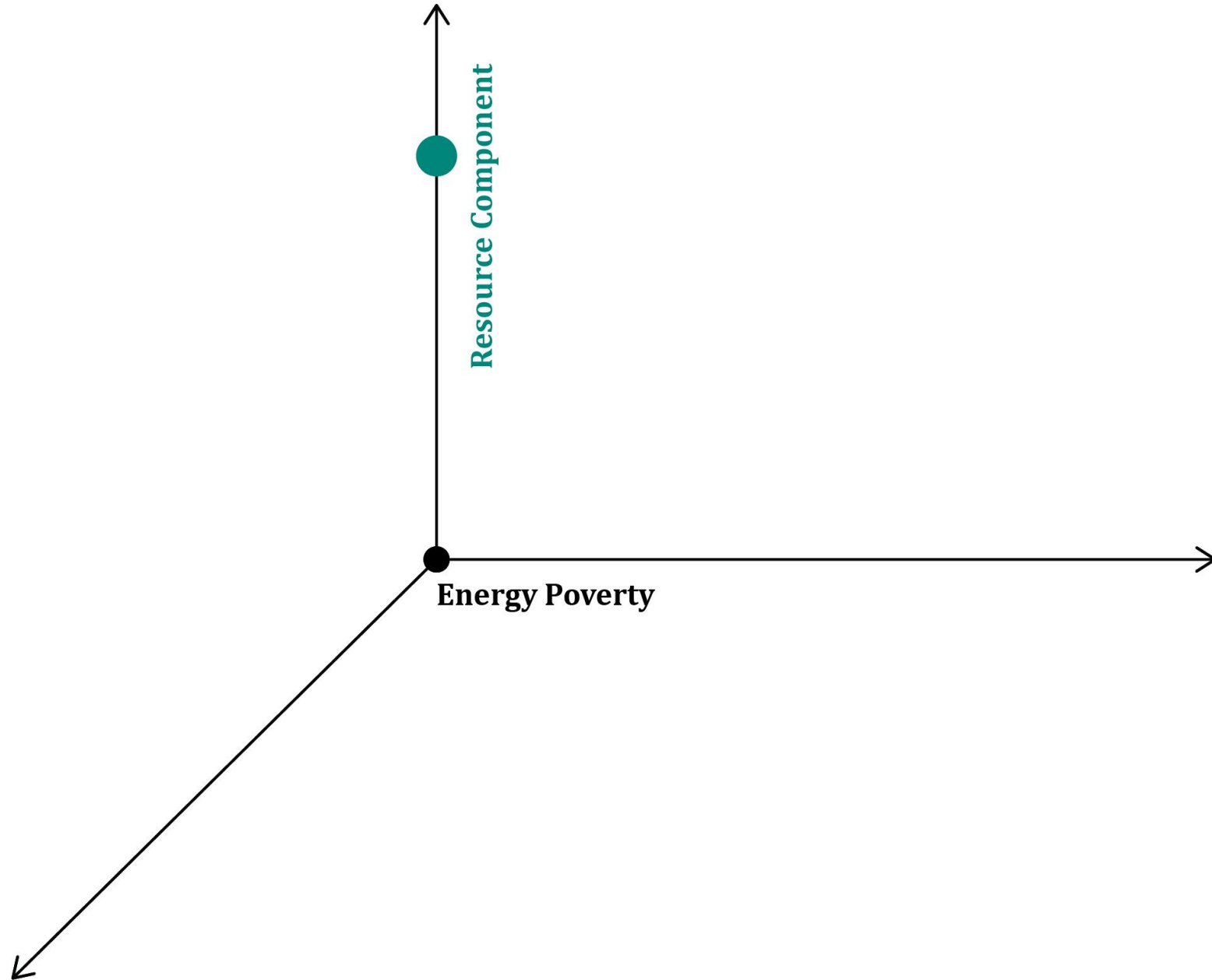
Level of Urbanisation



Energy Vulnerability







Rooftop solar



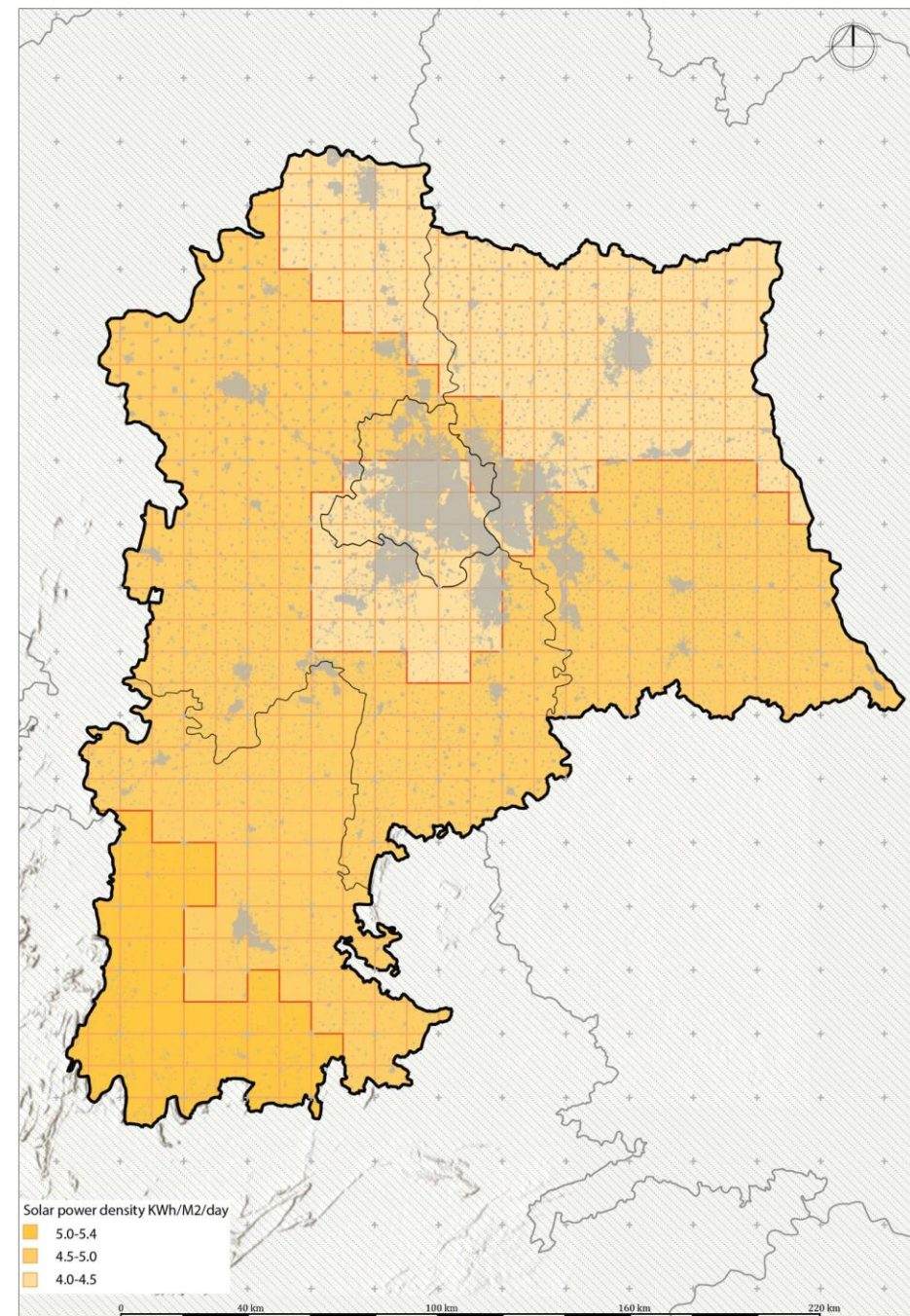
Micro-grids



Large scale solar farms



Solar Potential



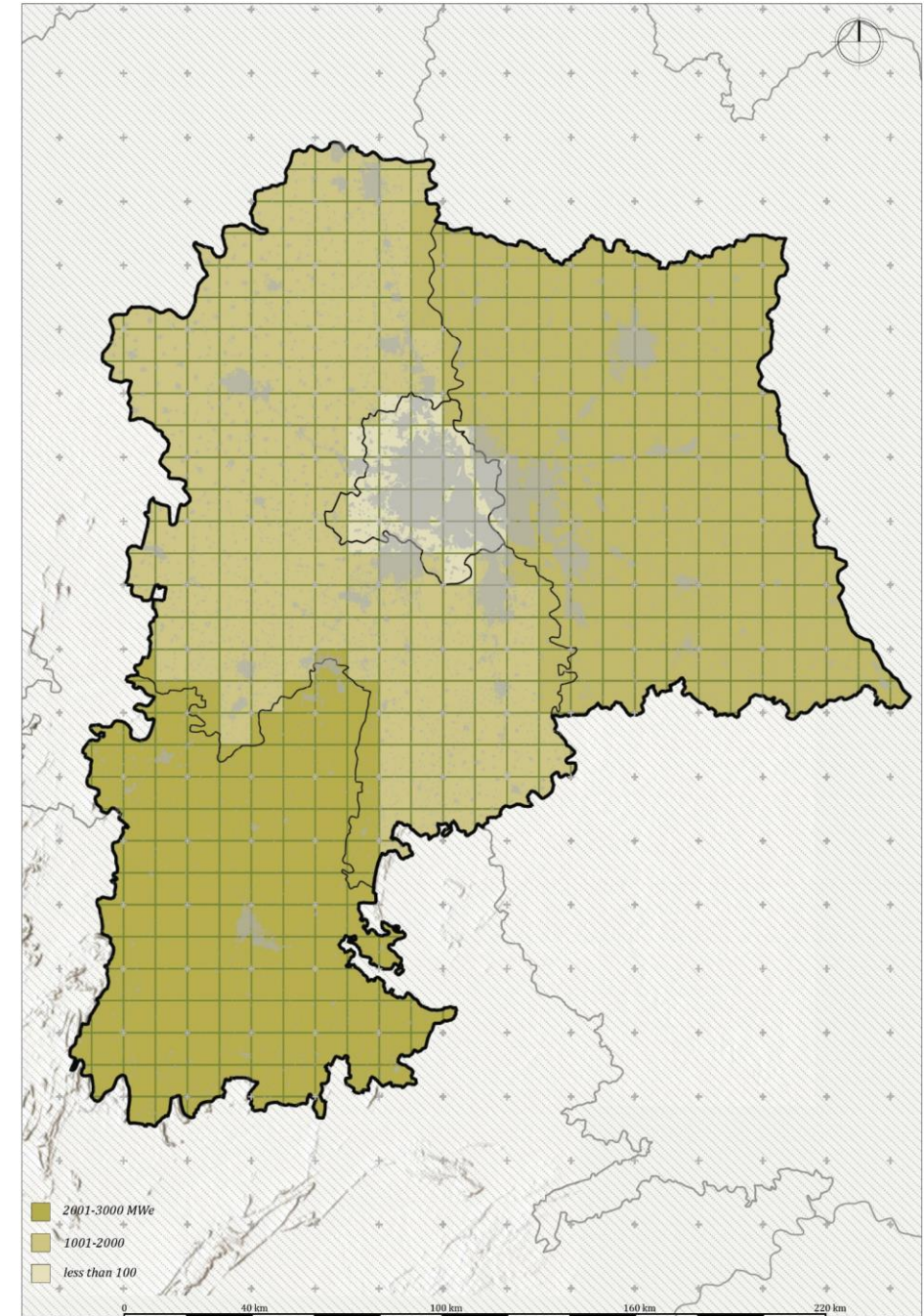
Stubble burning



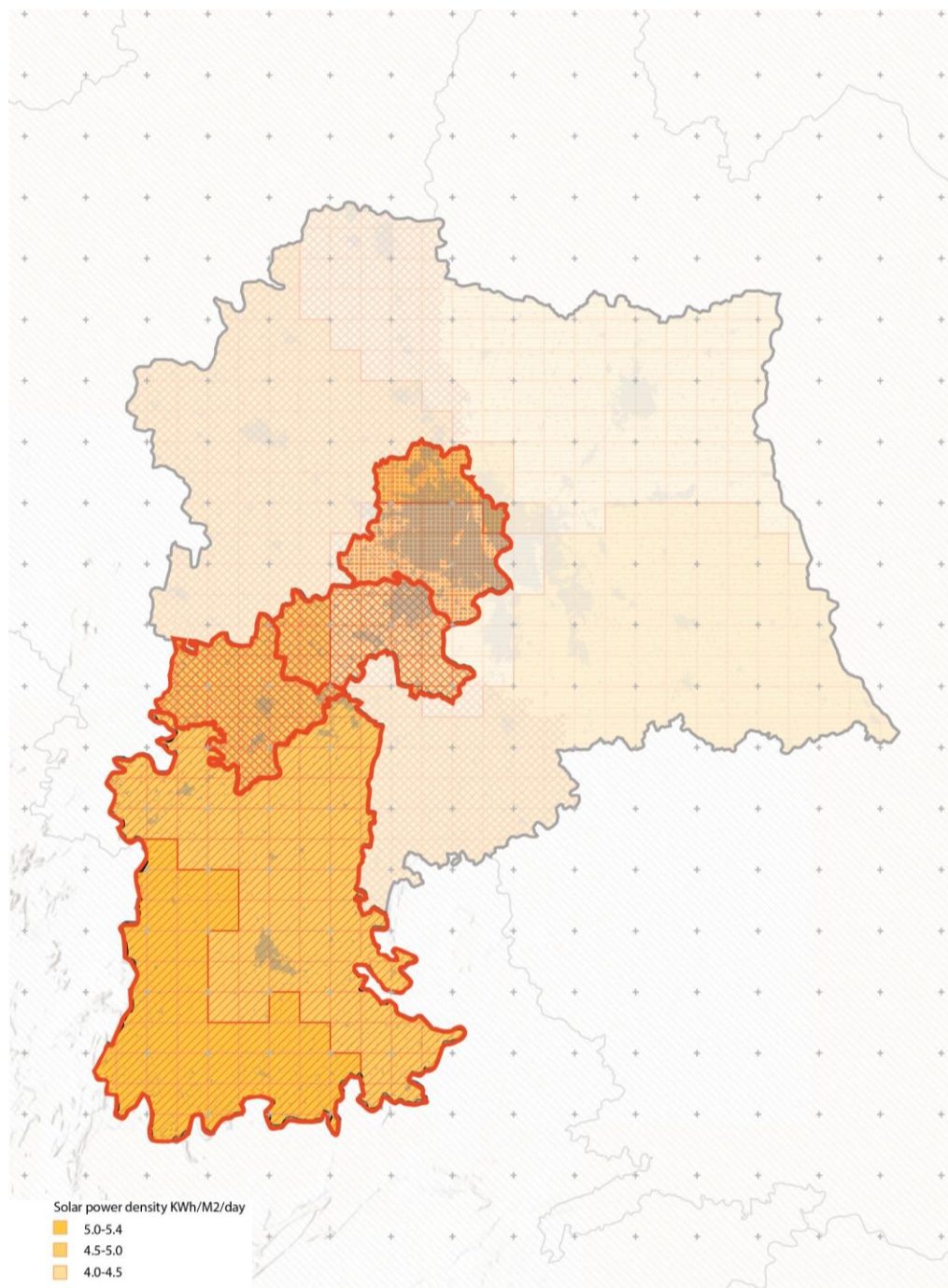
Agriculture field residue



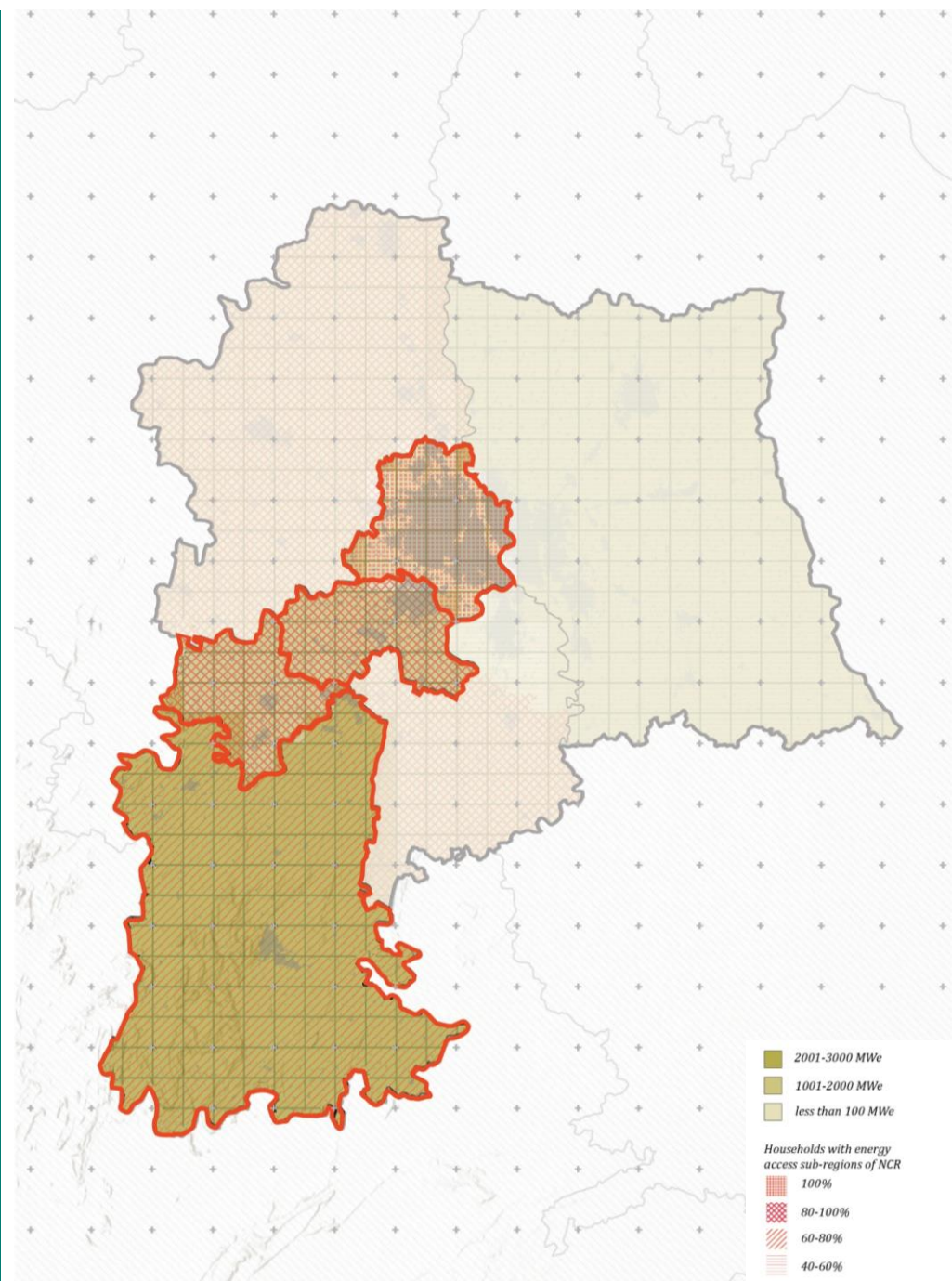
Biomass Potential

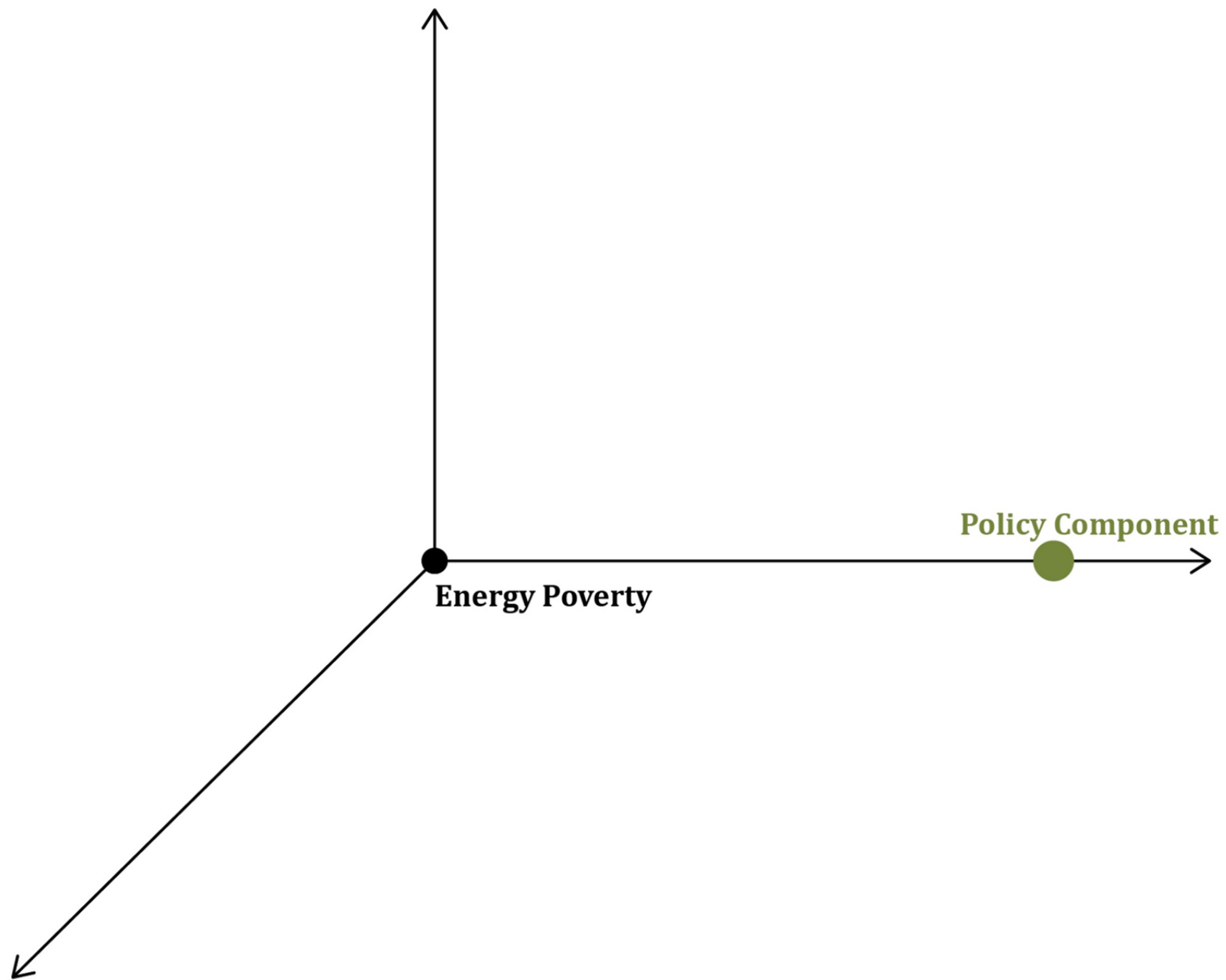


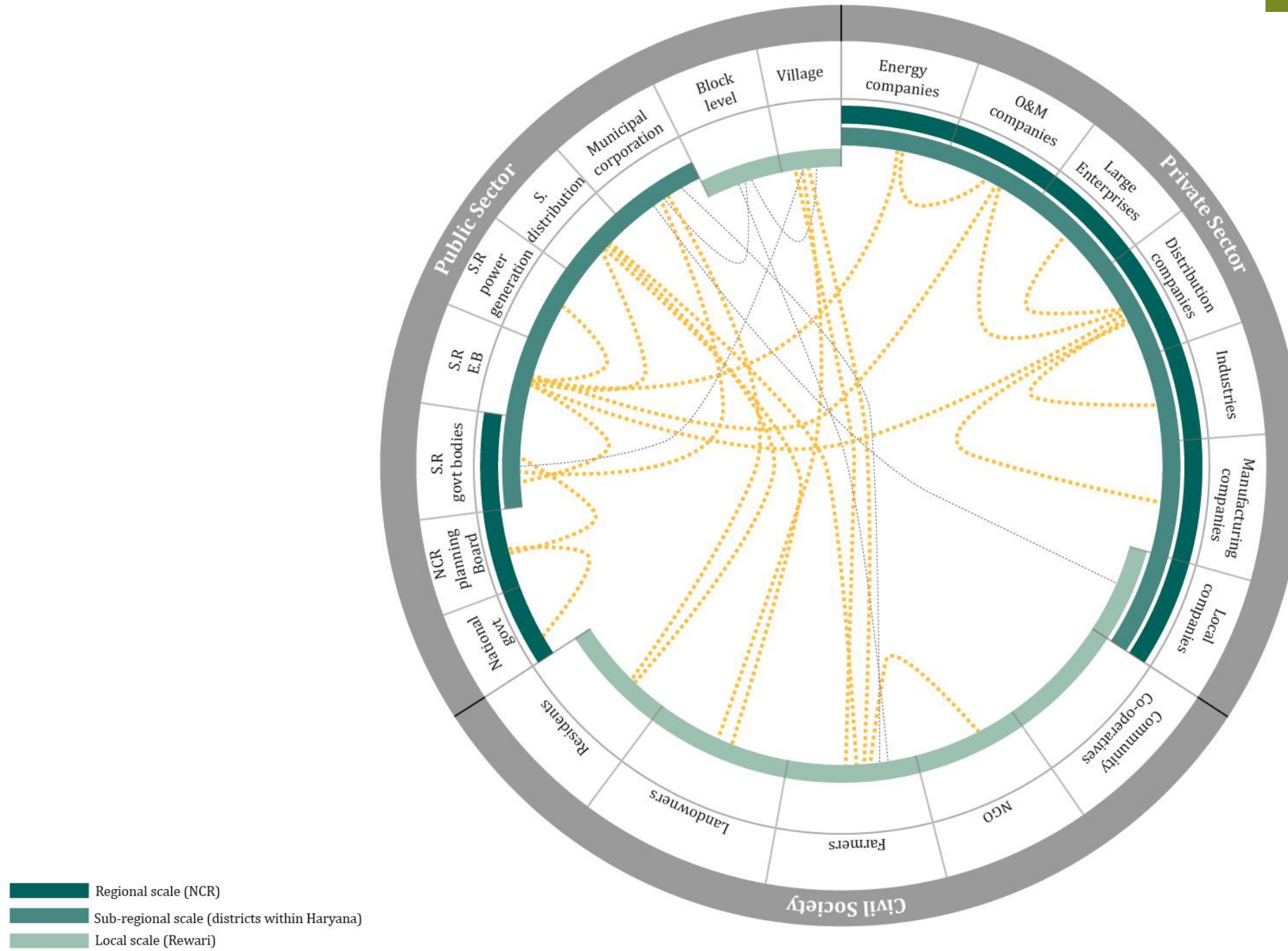
Energy Access + Solar Potential in Transect

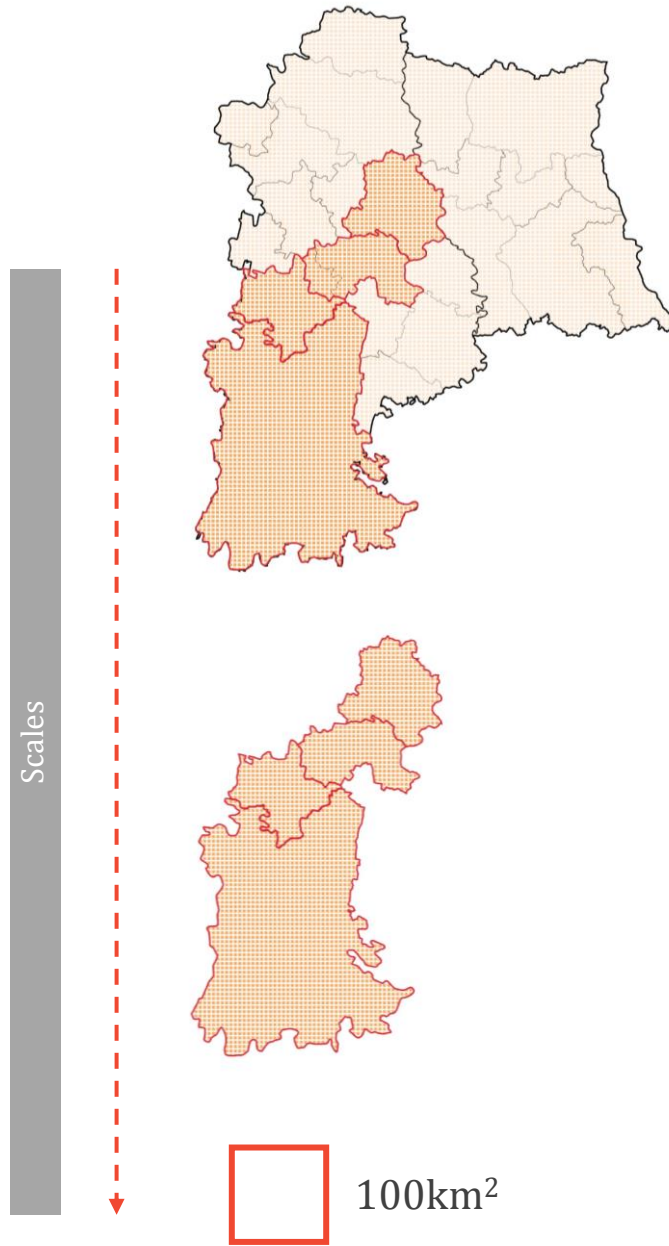


Energy Access + Biomass Potential in Transect









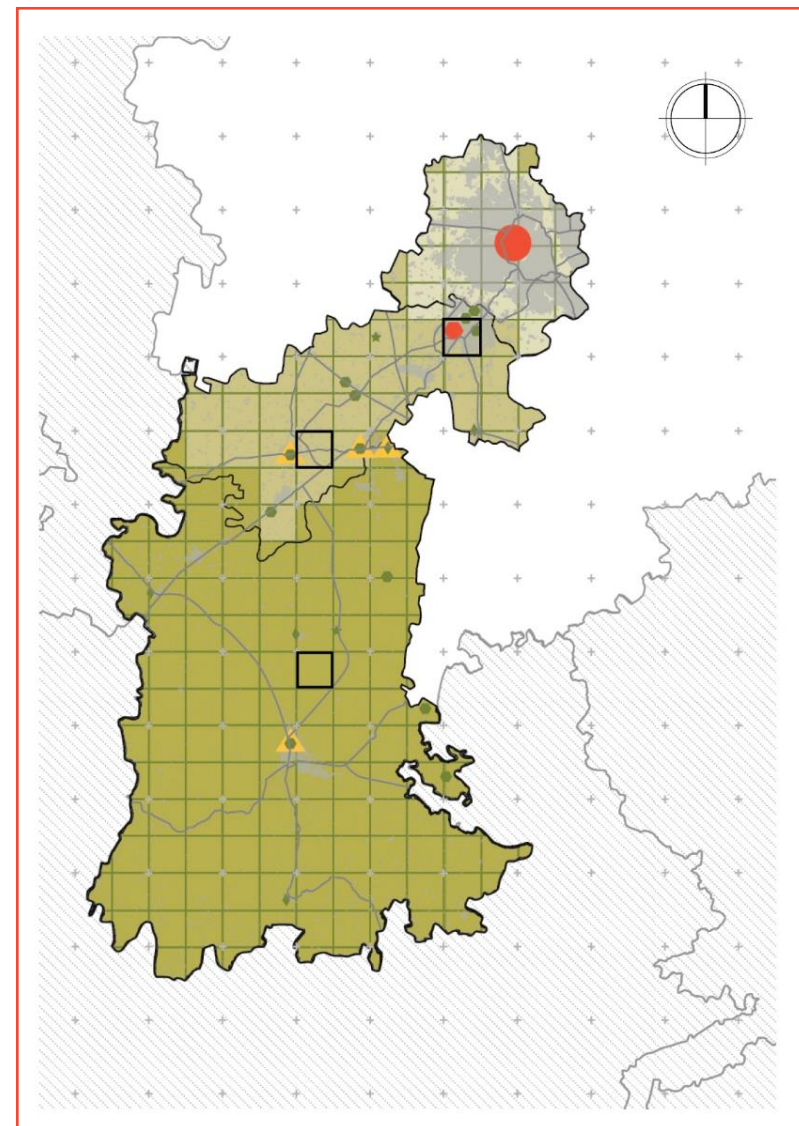
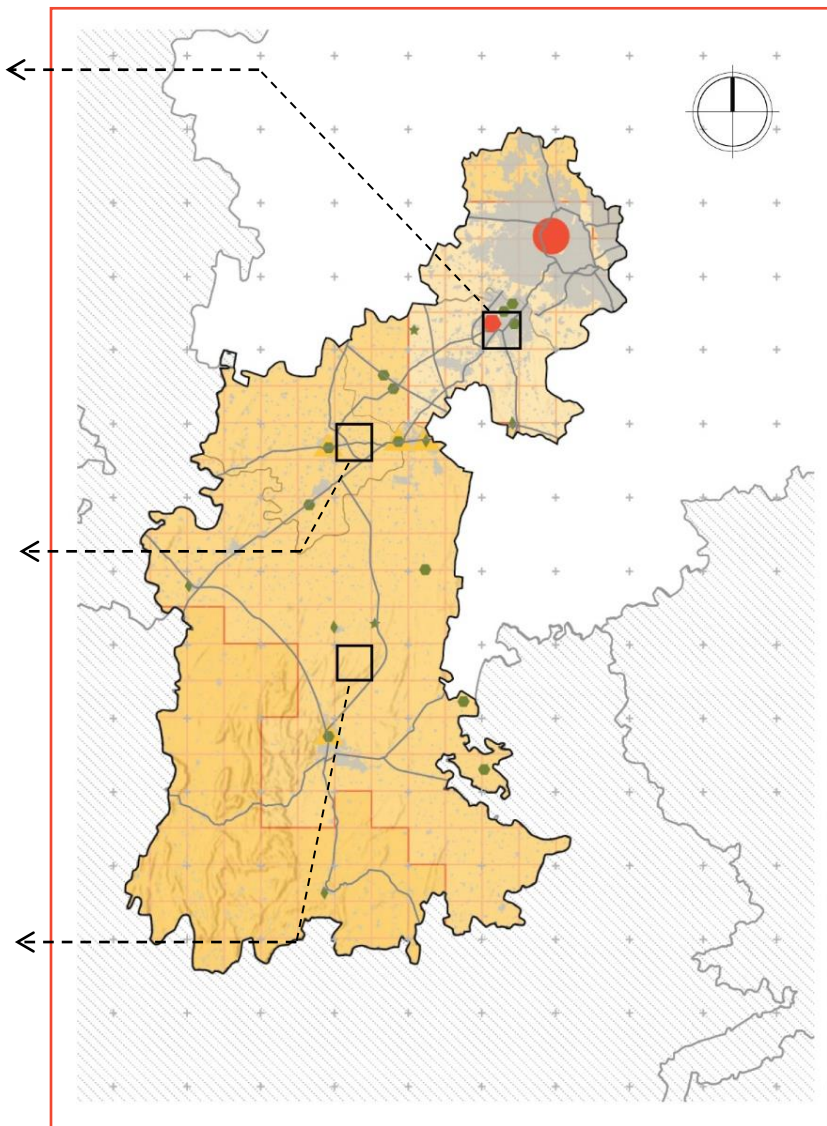
Urban

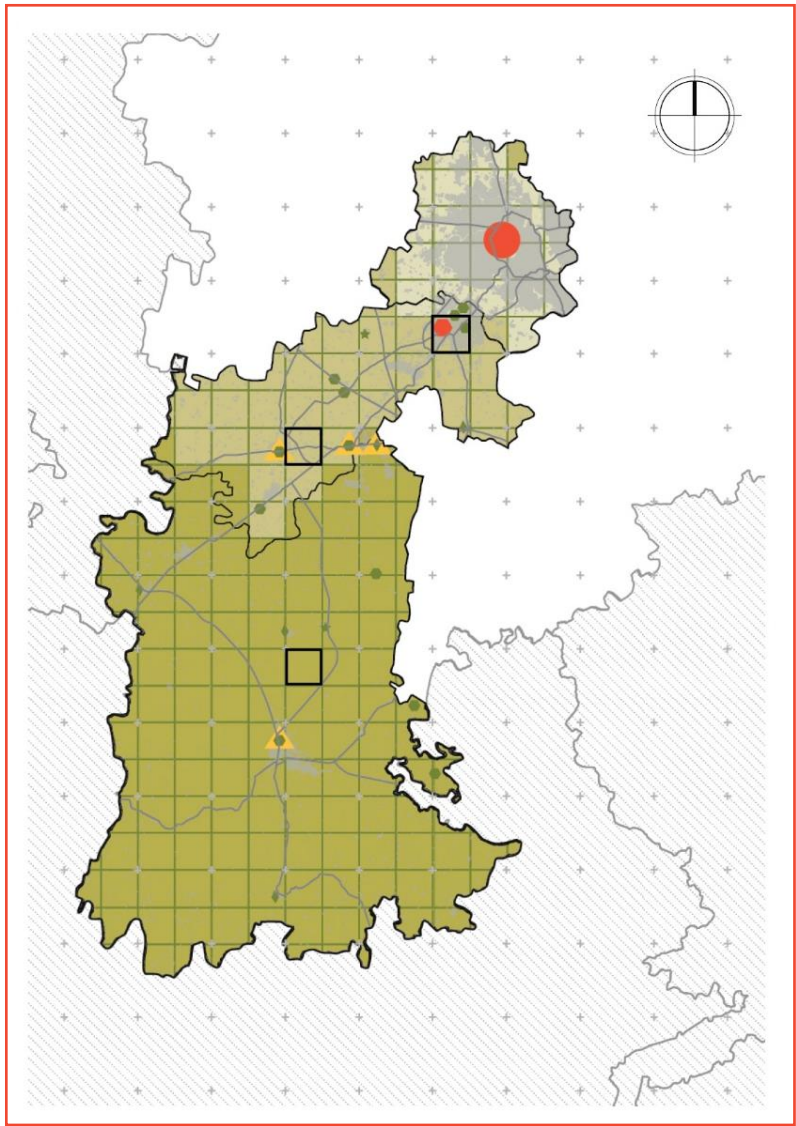
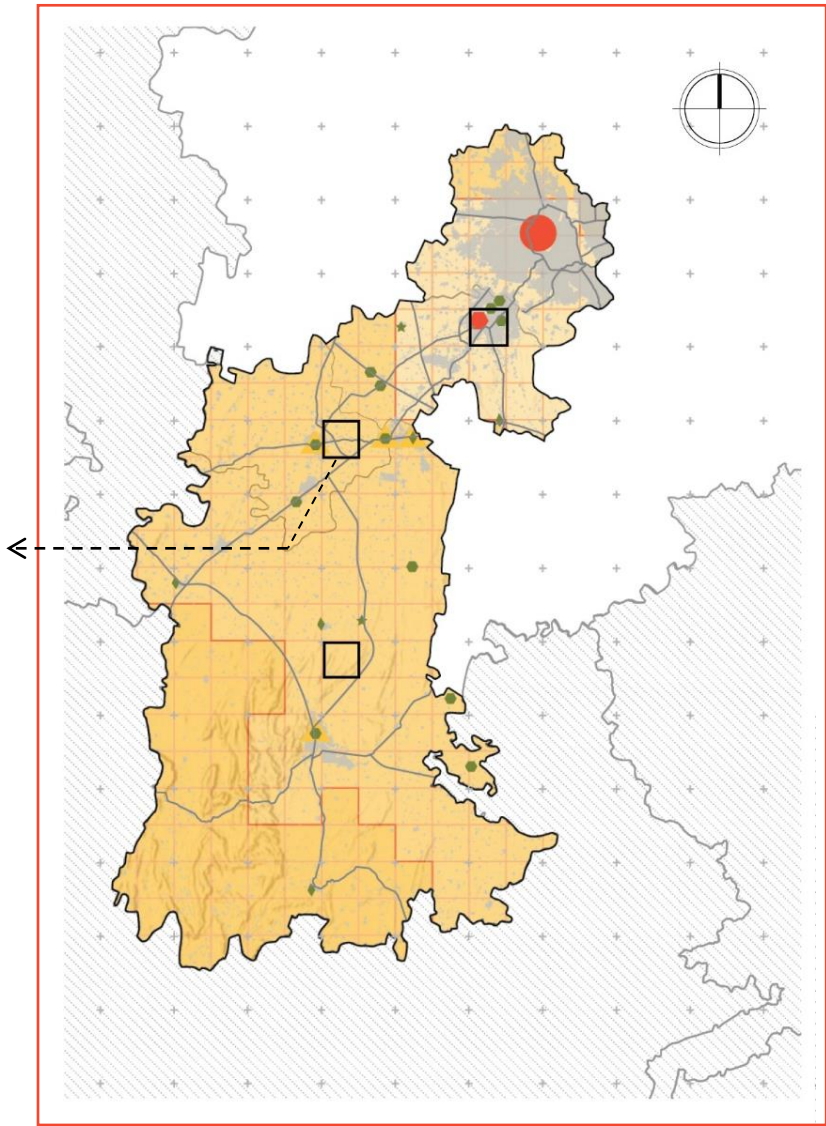


Urban - Rural

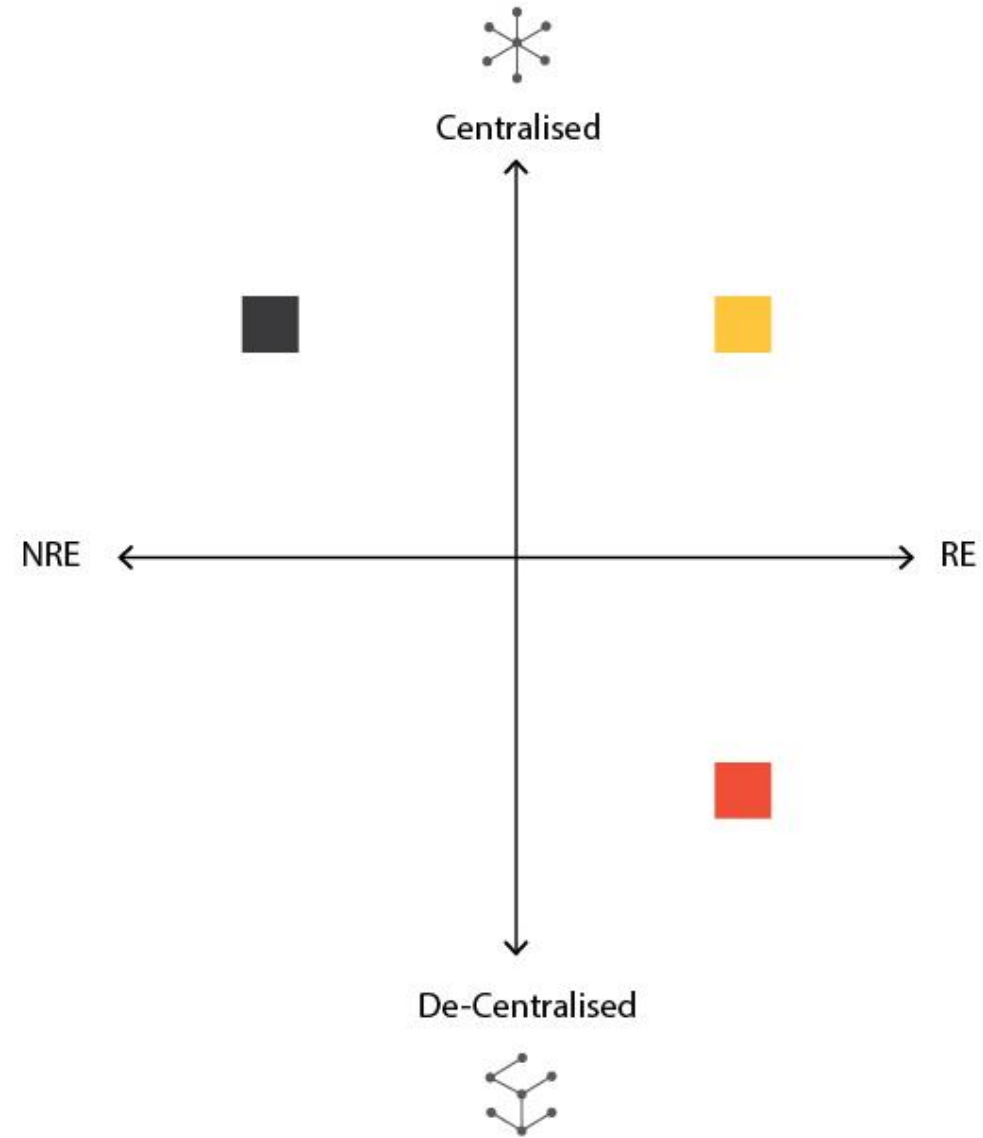


Rural





Research by design





Centralised



NRE ←

→ RE

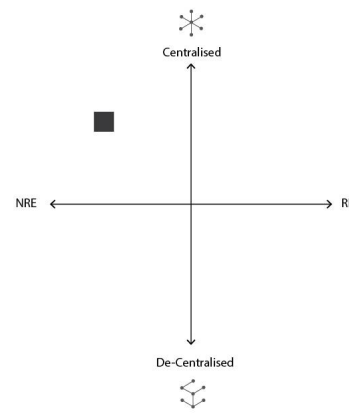
Scenarios 2051

De-Centralised



Centralised N.R.E system

| Example |



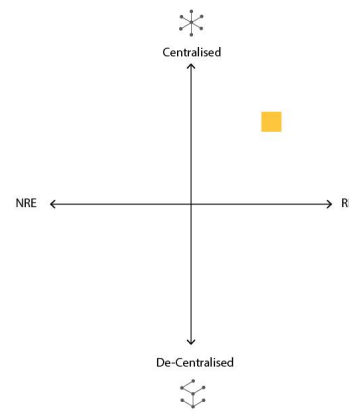
Source : www.theweek.in



Source : www.businessday.in

Centralised R.E system

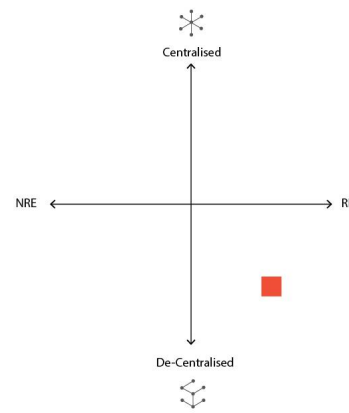
| Example |



Source : www.opusmagnagroup.com



Source : www.bigstock.com



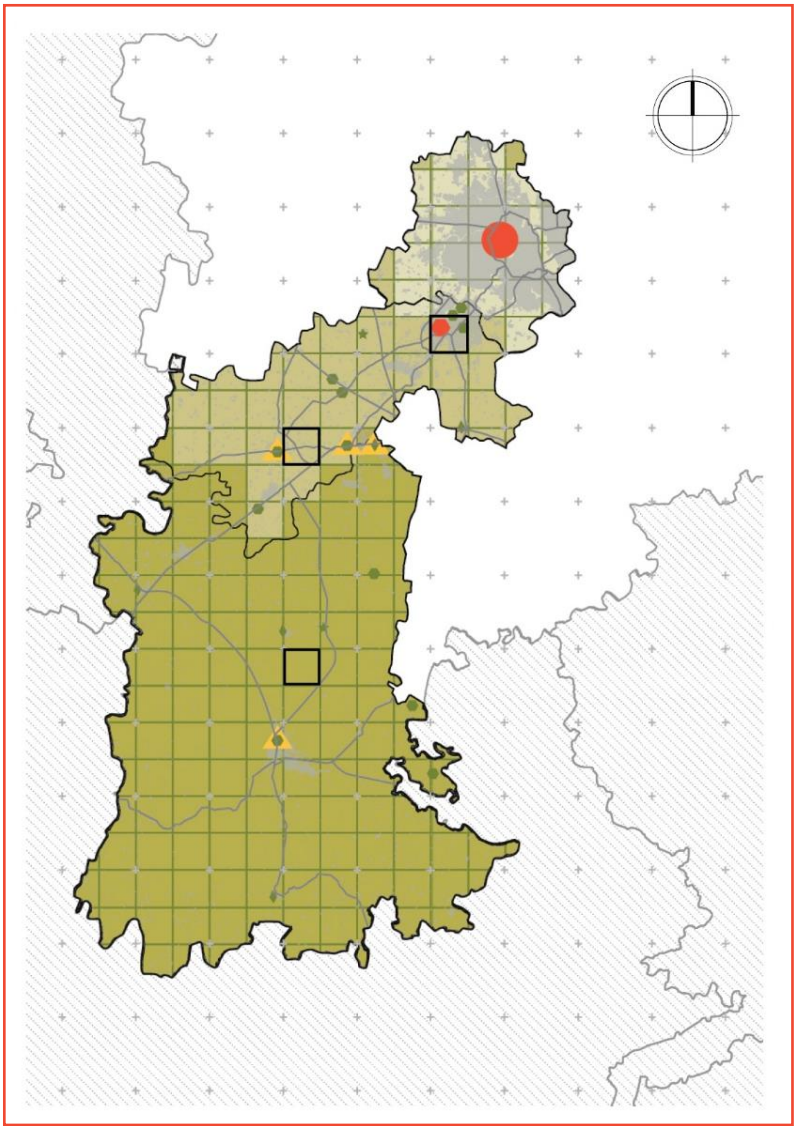
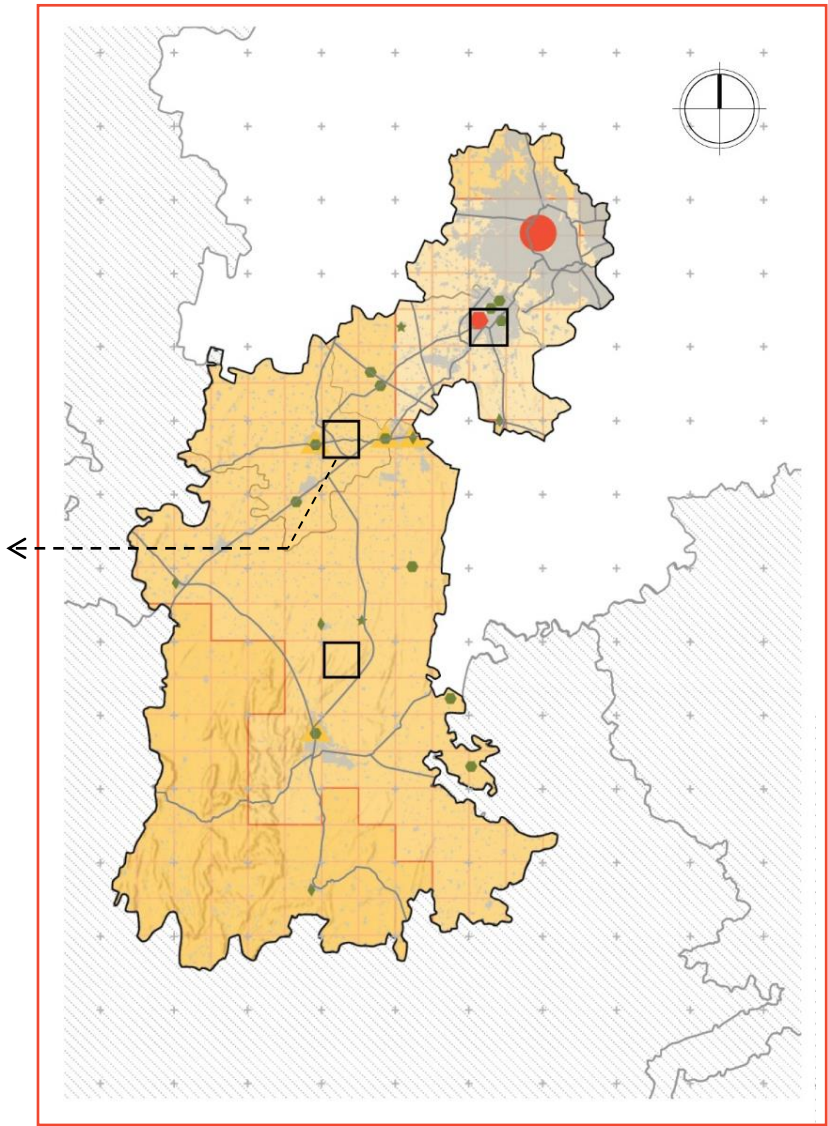
Source : www.opusmagnagroup.com

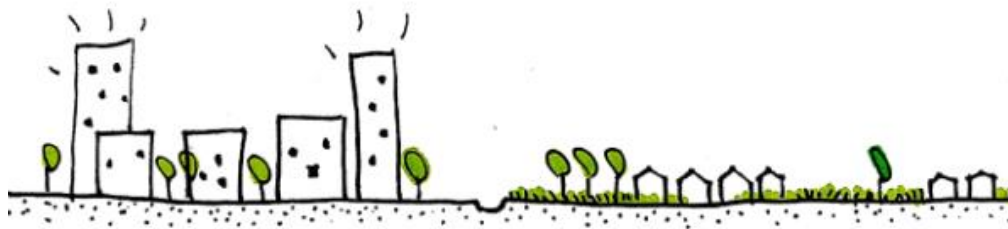
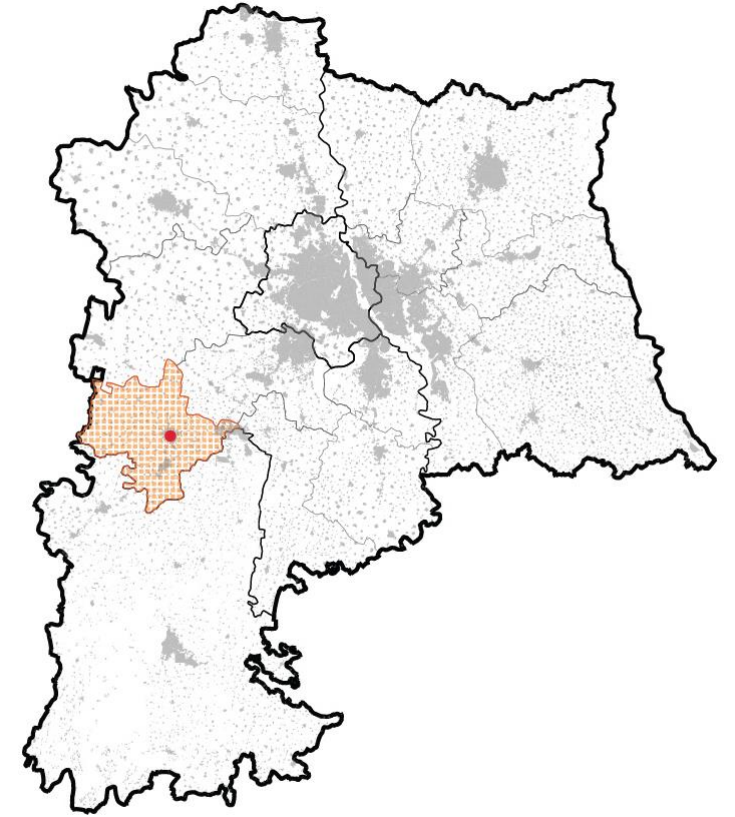


Source : www.alternative-energies.net



Source: google earth, 2019

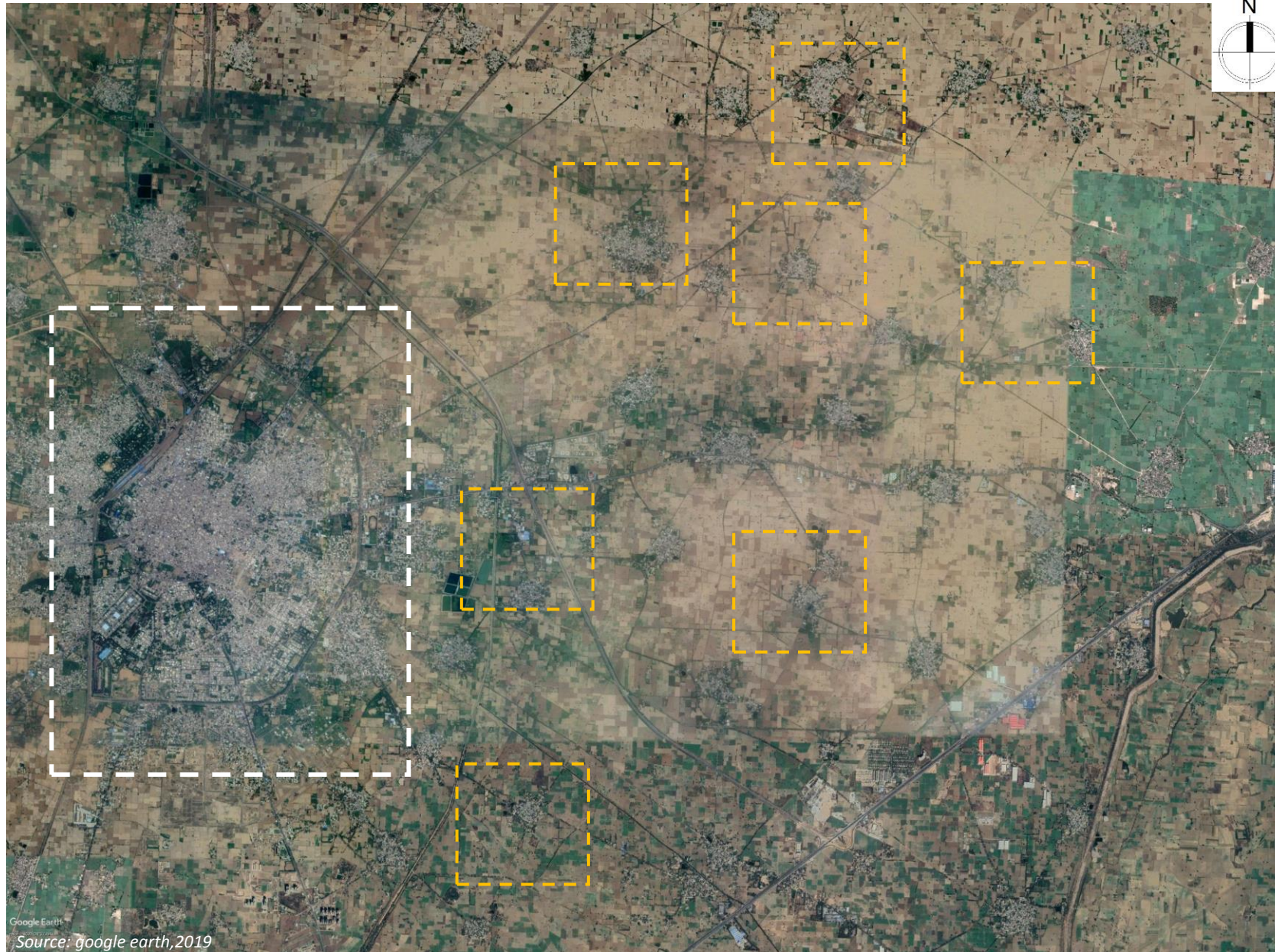






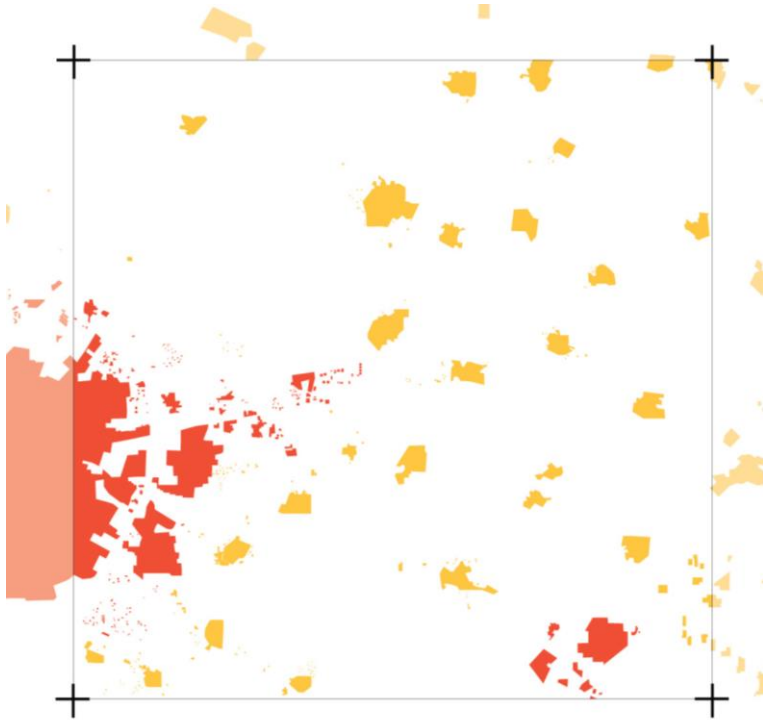
Source: google maps, 2019

Existing status quo



Existing status quo

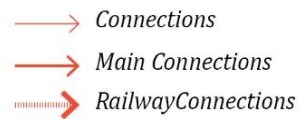
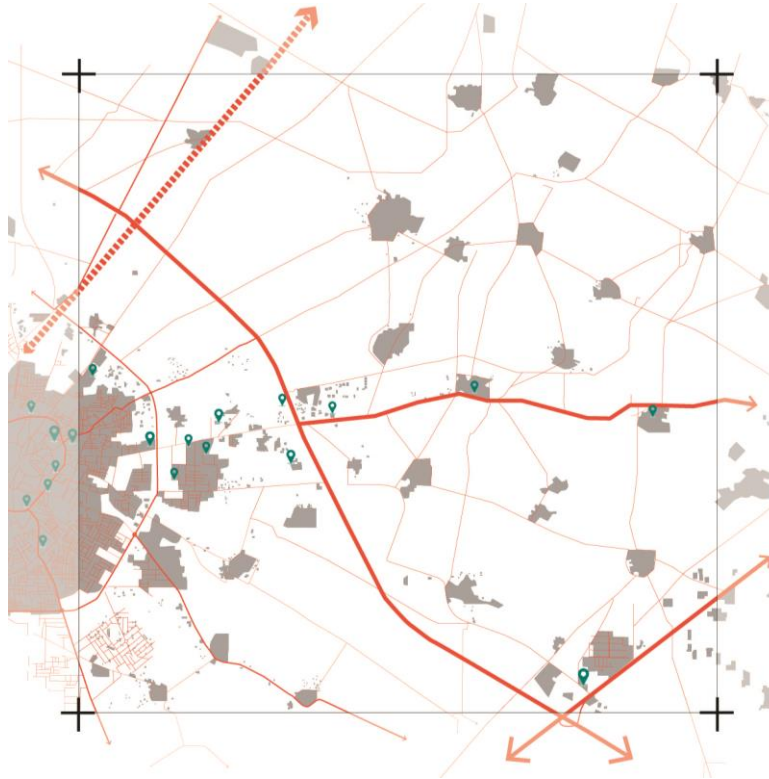
Built up area



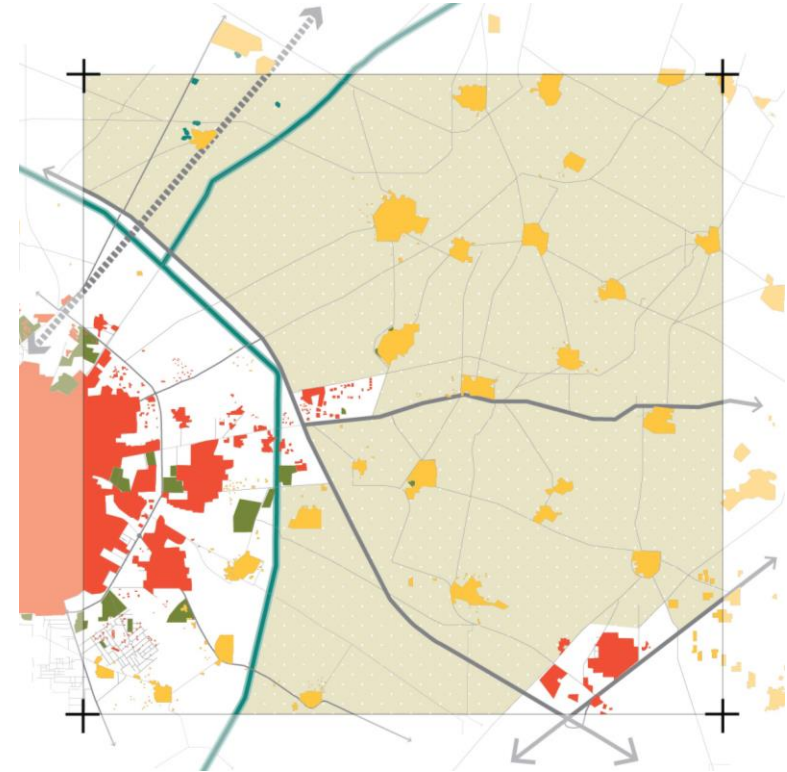
Built up area : 12 km²
Urban: 8km²
Rural: 4km²

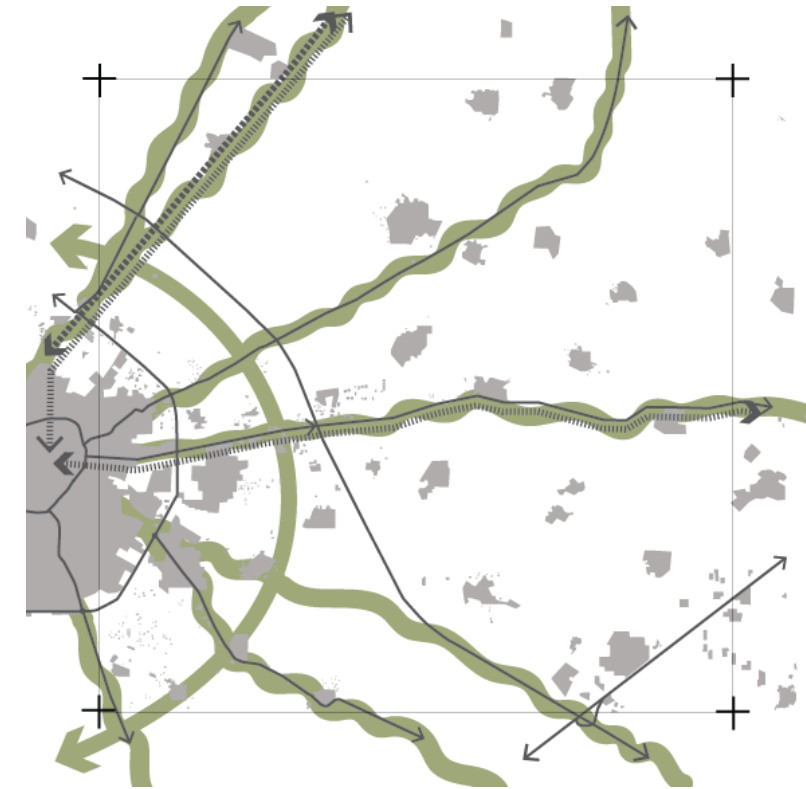
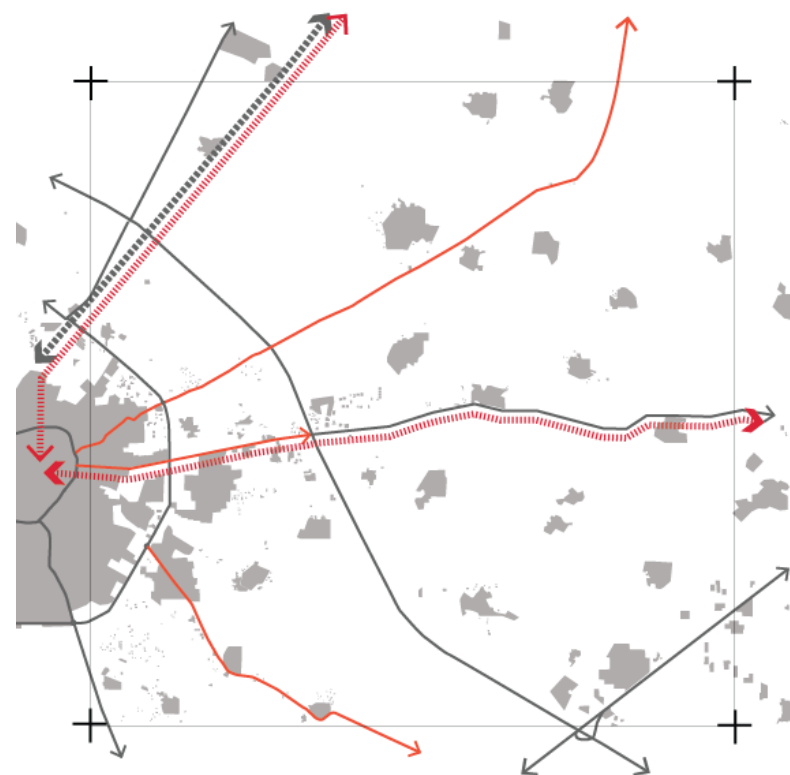


Infrastructure lines



Green-blue network





Densify

Densify areas to prevent sprawling into rural areas and agricultural fields

Transit support

Creating strong infrastructure lines to facilitate movement and encourage development

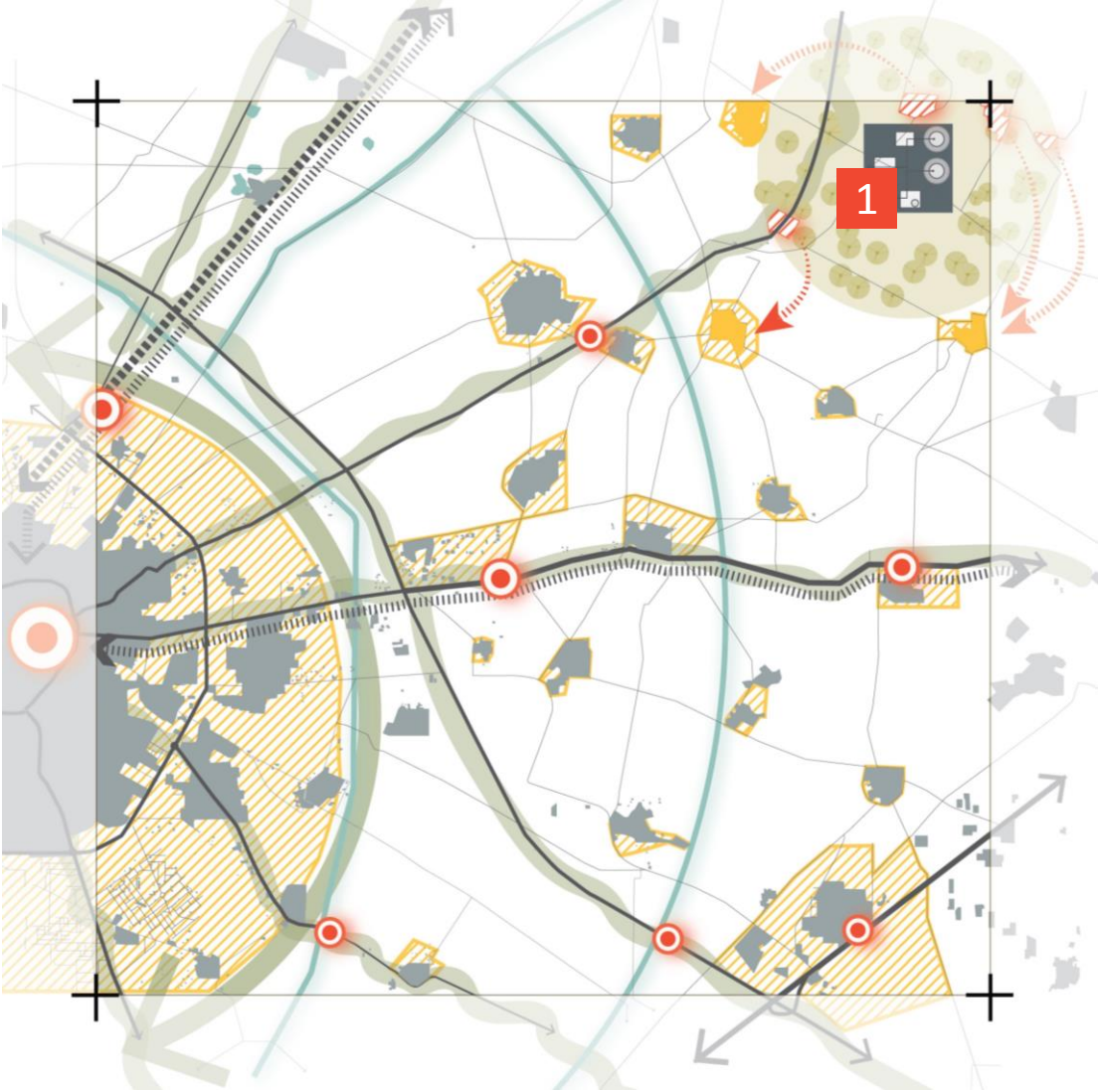
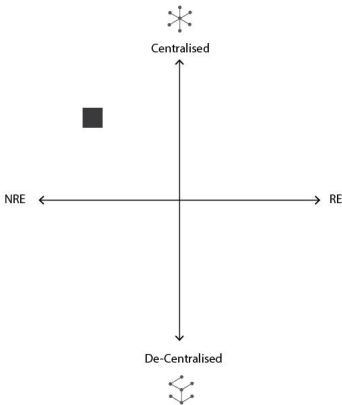
Economic zones

Possibilities of starting economic zones in the area

Natural system preservation

Focusing on ways in which the impacts on the ecological system is reduced

| Scenario 1 | 2051

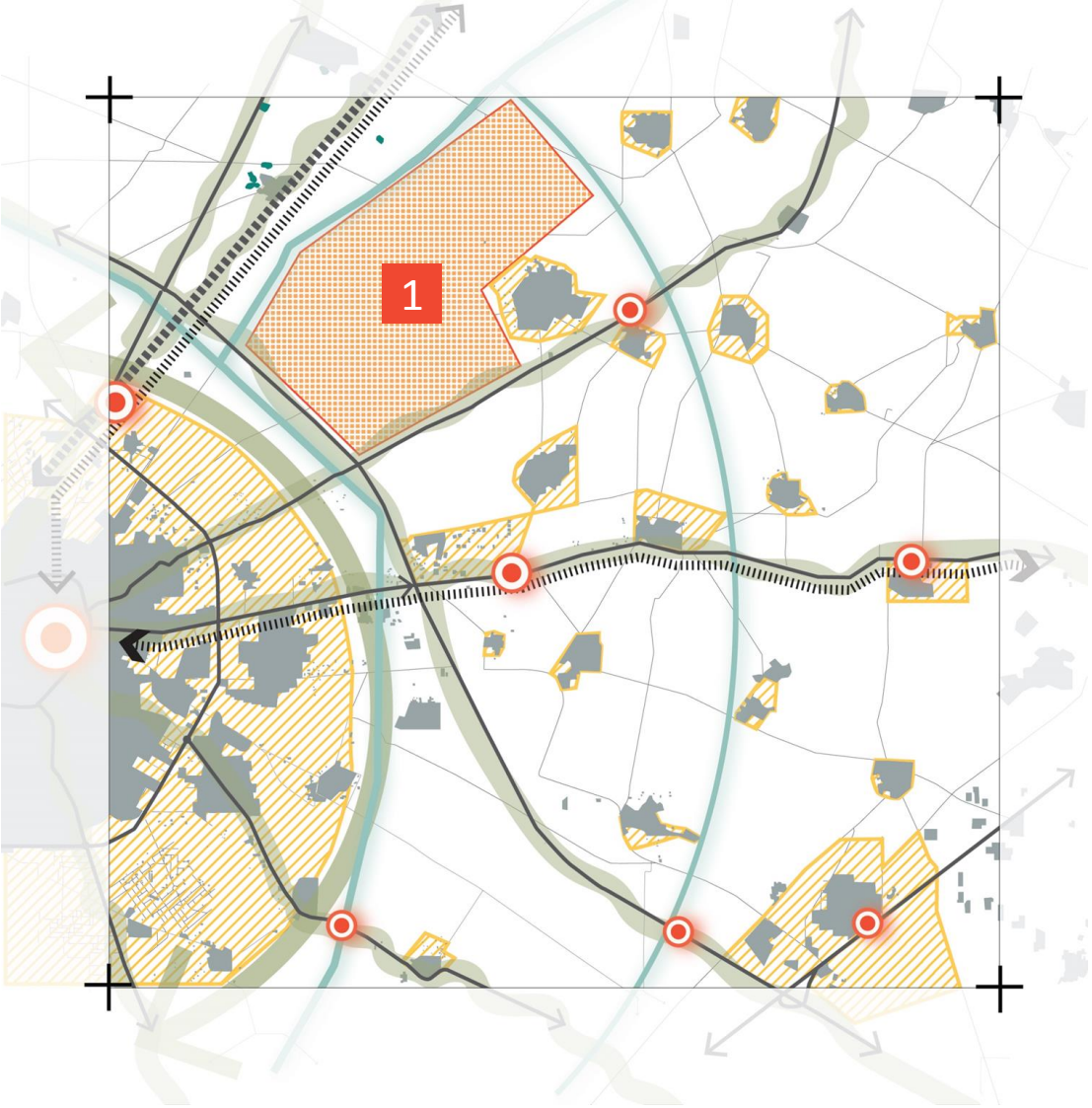
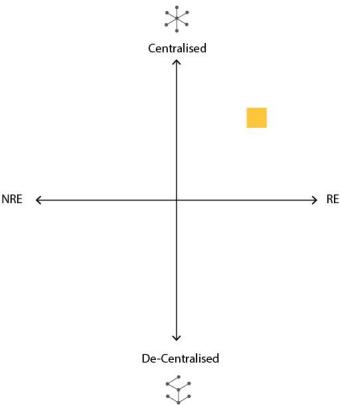


Thermal power plant : 1.5km²

- Existing built up
- Villages to be relocated
- Expansion area
- Roads connecting villages
- Roads connecting to city
- New Metro connection
- Existing railway lines

1



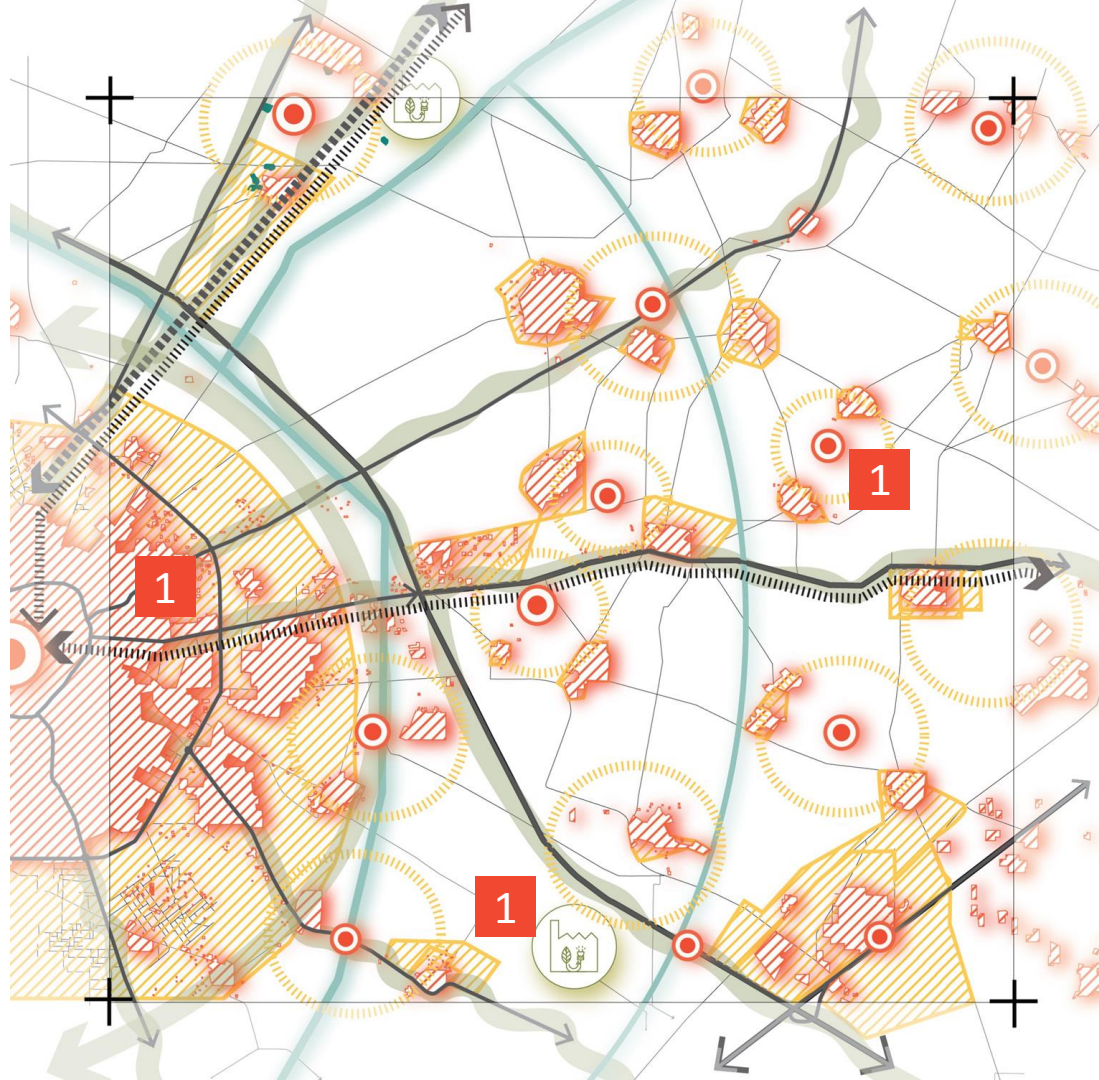
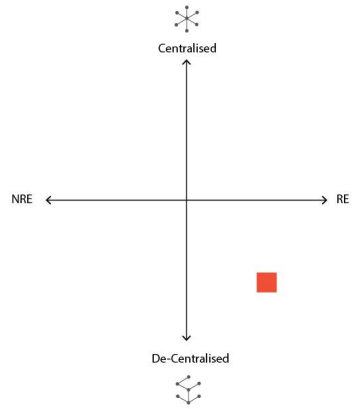


Solar farm : 5.3km²
Biomass farm : 343km²

1



| Scenario 3 | 2051

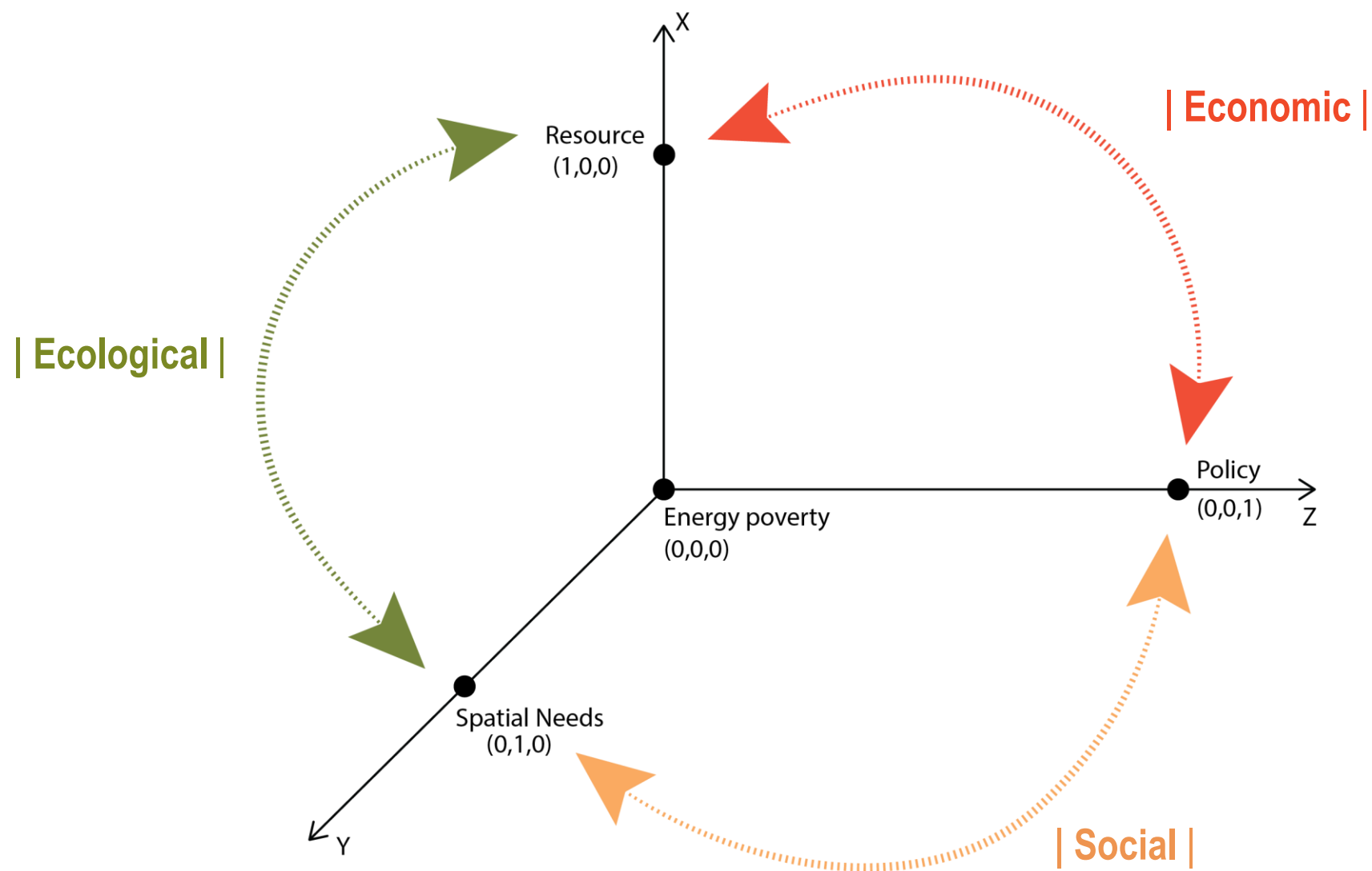


50% biomass crop : wheat






Biomass farm : 30km²

Solar area : 4.8km²








Ecological

	Food production
	CO2 emissions
	Water demand
	Land requirement
	Waste management

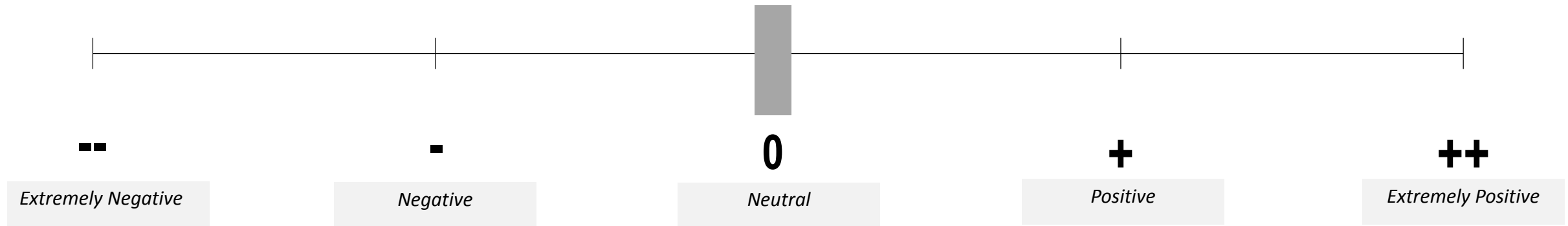
Social

	Village location
	co-operation between communities
	Health benefits
	Equity in access
	Job creation

Economic

	Economic zones near villages
	Energy surplus
	Energy reliability

| Impact Assessment Criteria |



Legend

--ve : A very negative change and embodies no values of sustainability or circular economy, creating a long-lasting chain of negative events

-ve : A negative change to the existing status quo but embodies one aspect of sustainability or circular economy

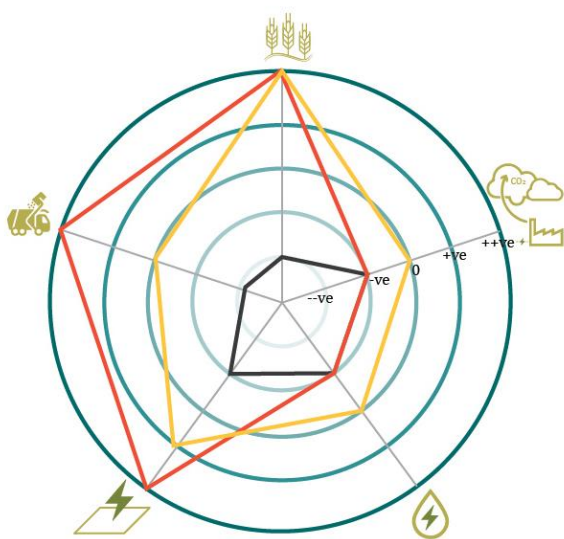
0 : Has no impact on the existing status quo

+ve : A positive change to the existing status quo and embodies one aspect of circular economy or sustainability

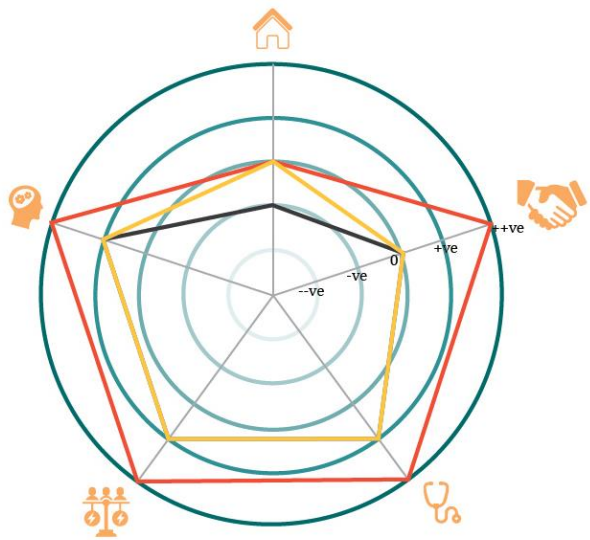
++ve : A very positive change and embodies multiple aspects of sustainability or circular economy.

**Assessment criteria is about impact that the energy system has on the area*

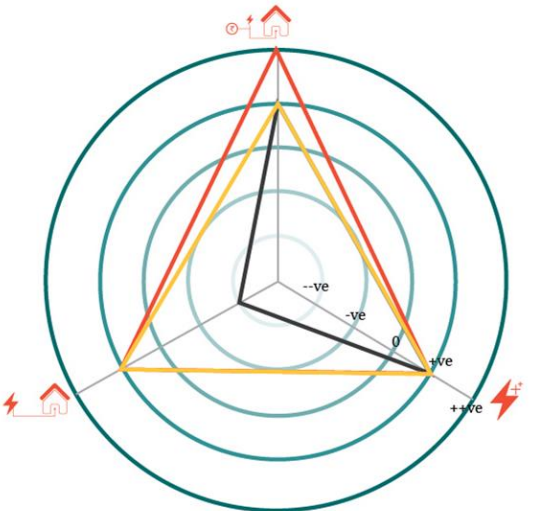
Ecological



Social



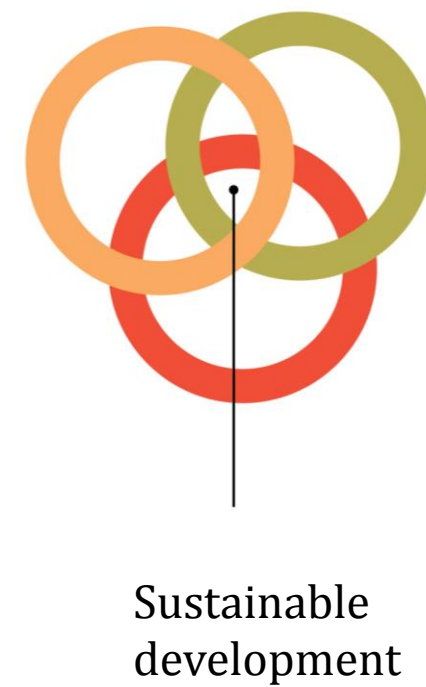
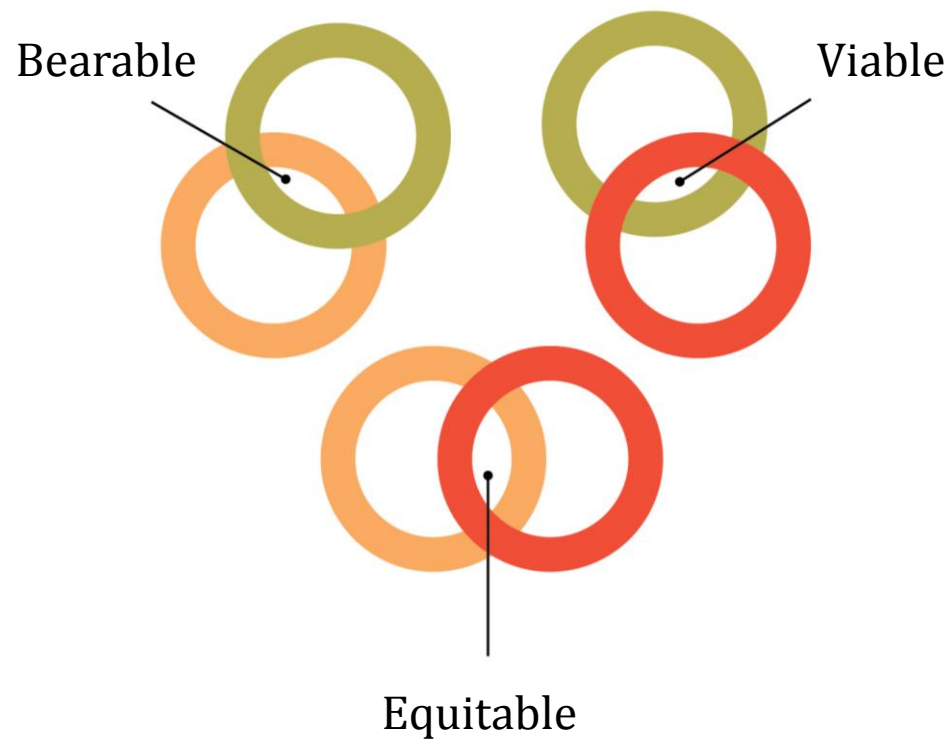
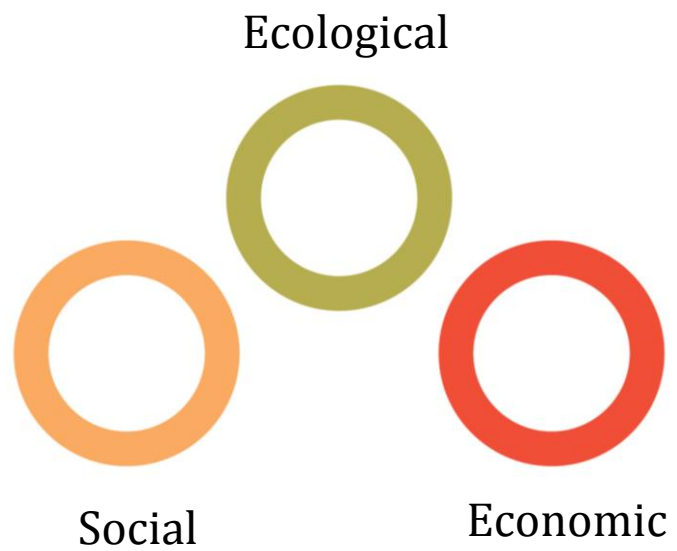
Economic



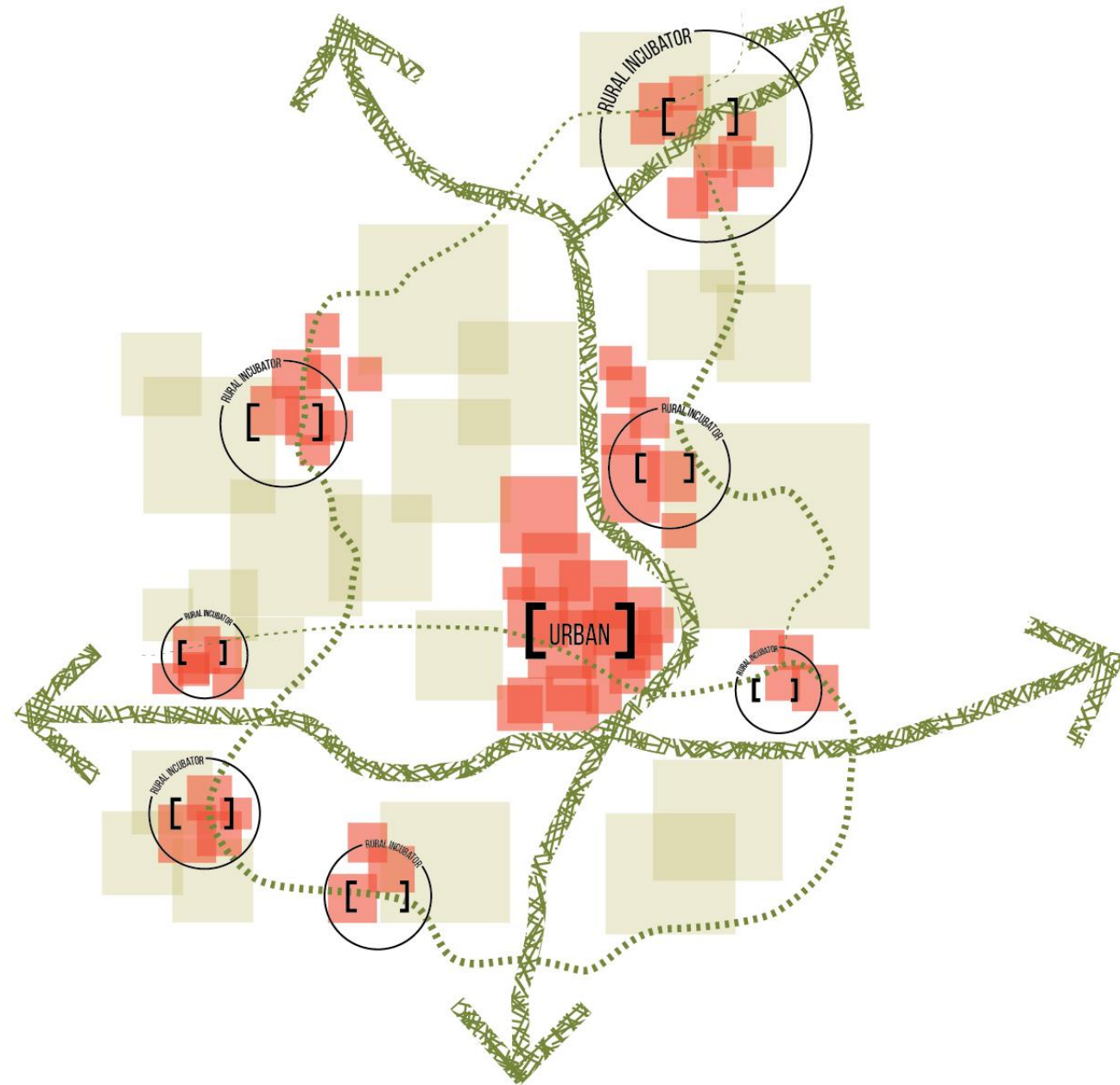
| Scenario 1 |

| Scenario 2 |

| Scenario 3 |



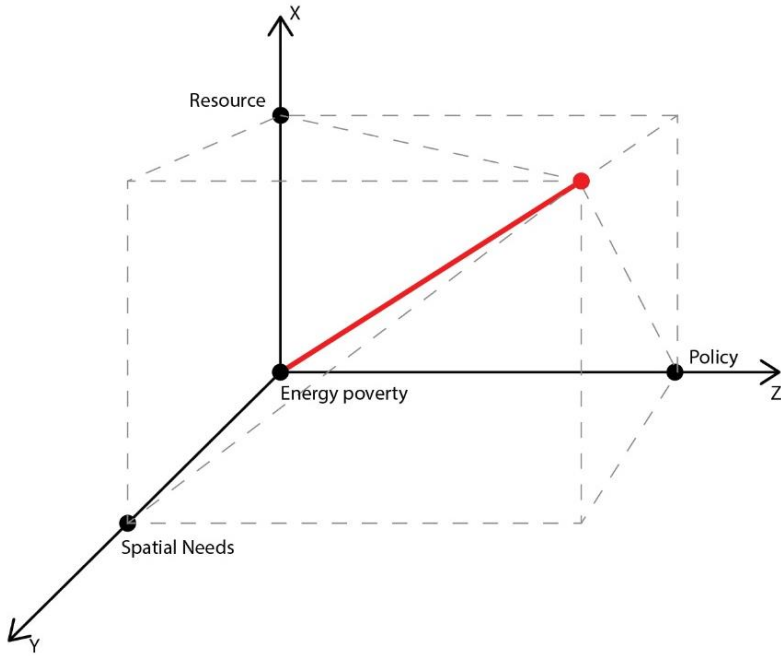
Vision & Strategies

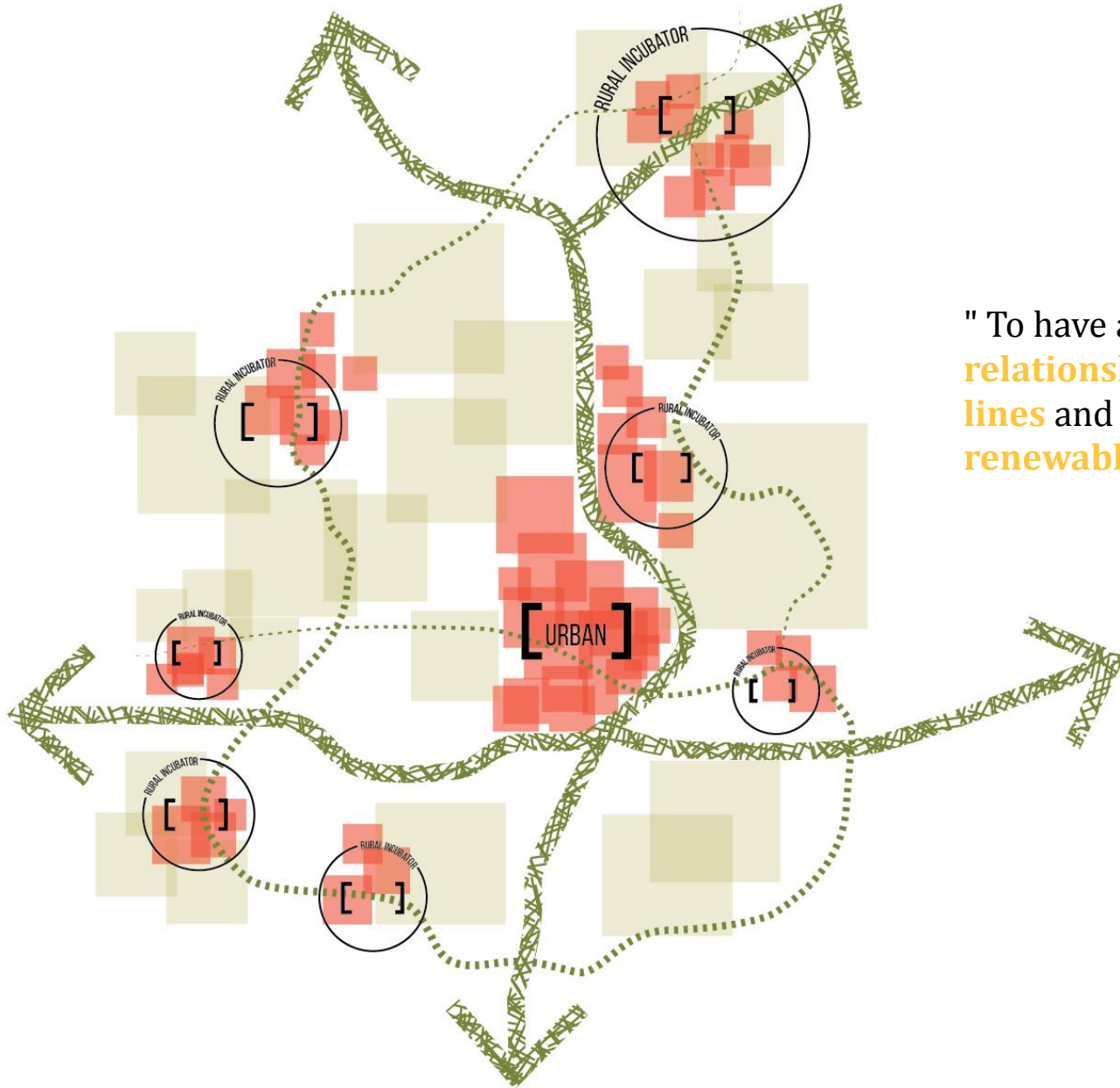


- Sustainable energy system
- Natural system preservation
- Increased social benefits
- Triggers economic activities
- Local circles of resource generation and exchange
- Infrastructure connections

Decentralised system of development

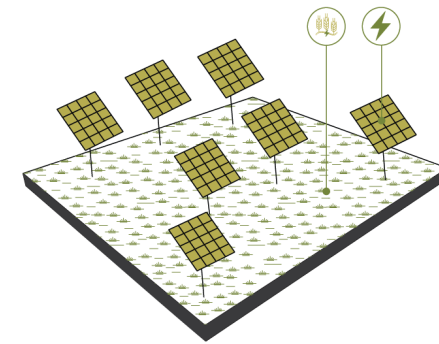
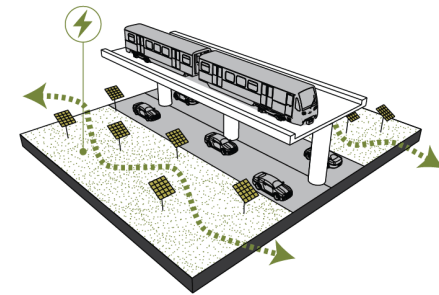
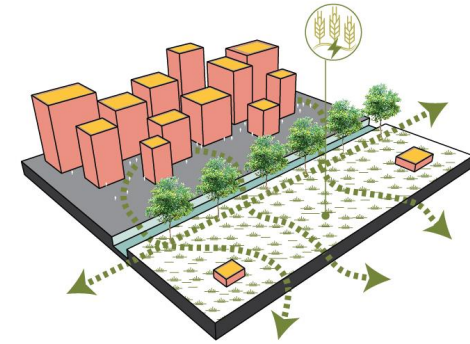
- Resource
- Policy
- Spatial



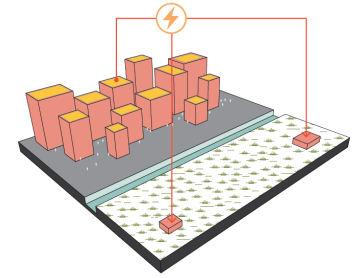


" To have an **interlinked network of rural incubators**, that has a **reciprocal relationship with urban areas** and is supported by **well-connected transit lines** and promotes knowledge and resource exchange to have a **just renewable energy transition** in the National Capital Region"

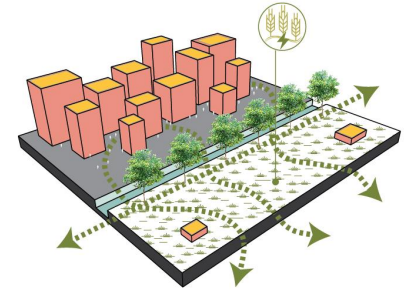
Strategies & Phasing



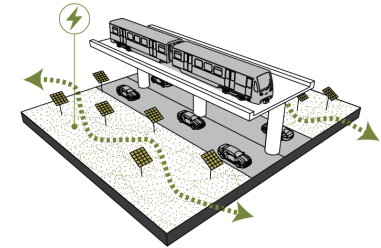
Shifting the role of dense urban areas: creating an urban source



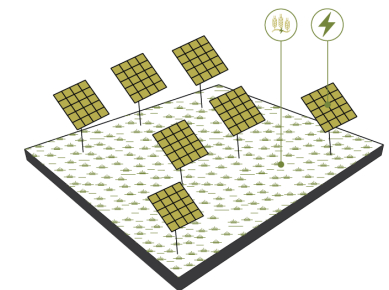
Setting up open source rural incubators: Empowering the rural areas



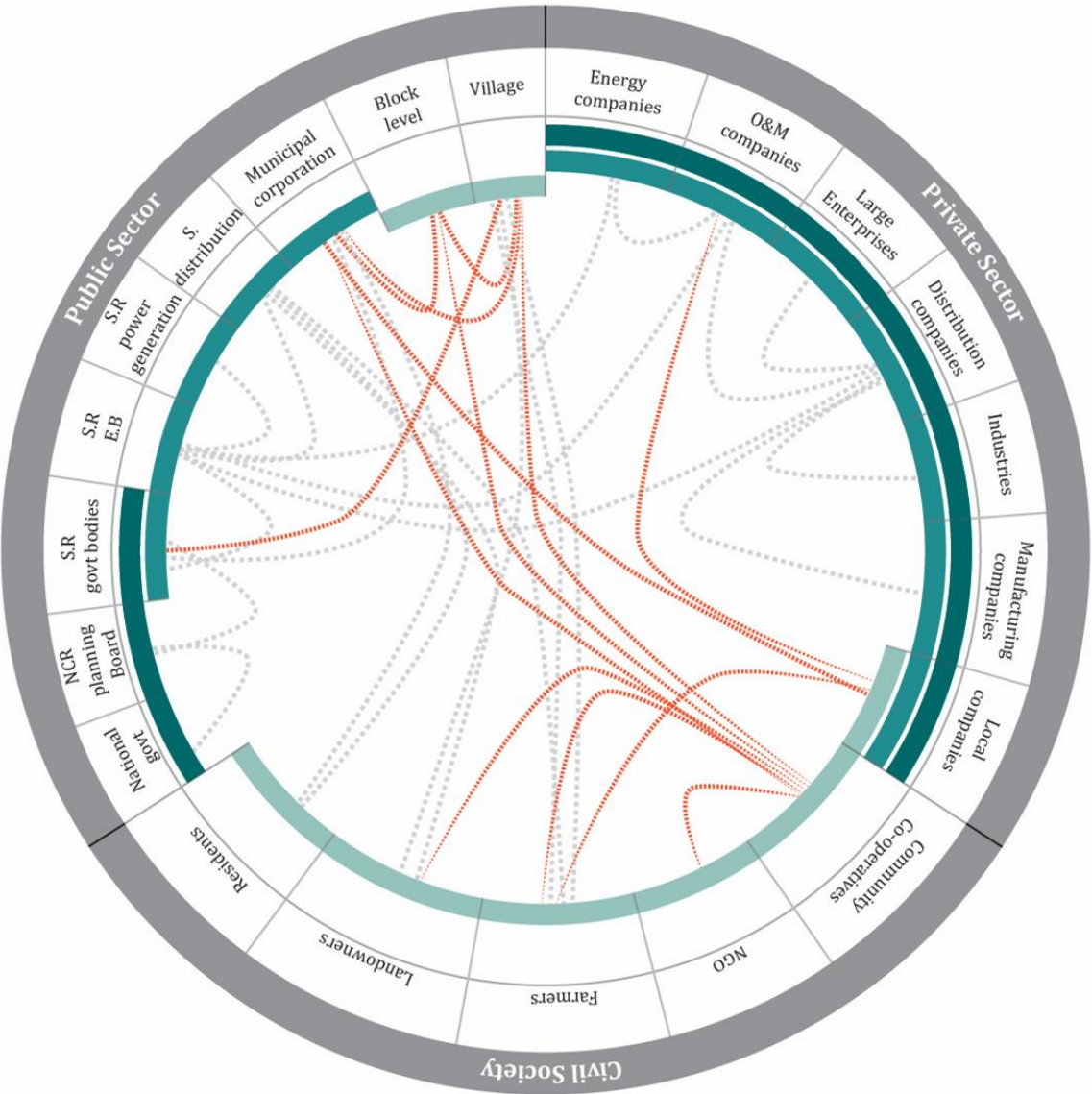
Extending transit lines to improve urban-rural connectivity



Rethinking “vs energy” as “and energy”: Cross-functional uses with technology







Shifting the role of dense urban areas: creating an urban source

Key



City level Biennale

Key



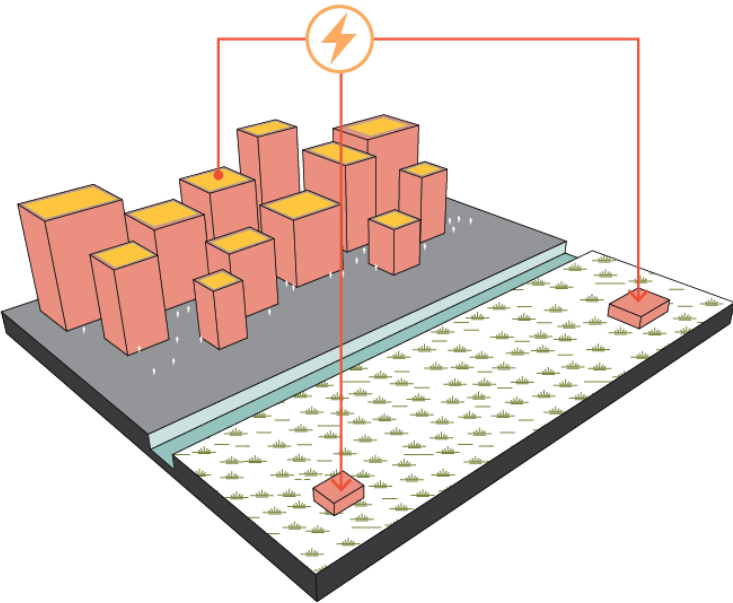
Mohalla sabha



Work groups
(from the rural areas)



Subsidies and
incentives



Surplus electricity
stored



Surplus



Prevent sprawl



BIPV



Retrofitted with solar
panels



Setting up open source rural incubators: Empowering the rural areas

Key



Primary public building

Key



Community organisations



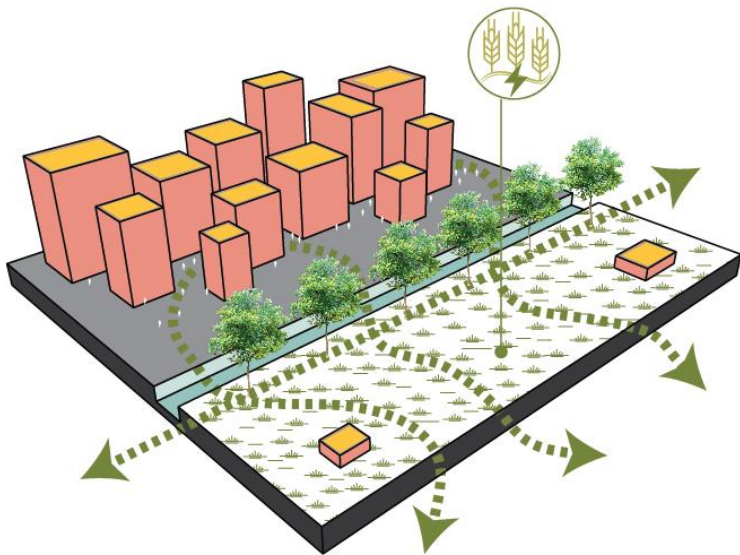
Participatory budgeting




Financial aid groups




Gender specific issues




Activities encouraged




Biomass plants set up




Linked to renewable energy sources



Rural incubator



Exchange of resources



Extending transit lines to improve urban-rural connectivity



Primary transit lines
linked to renewable
energy source

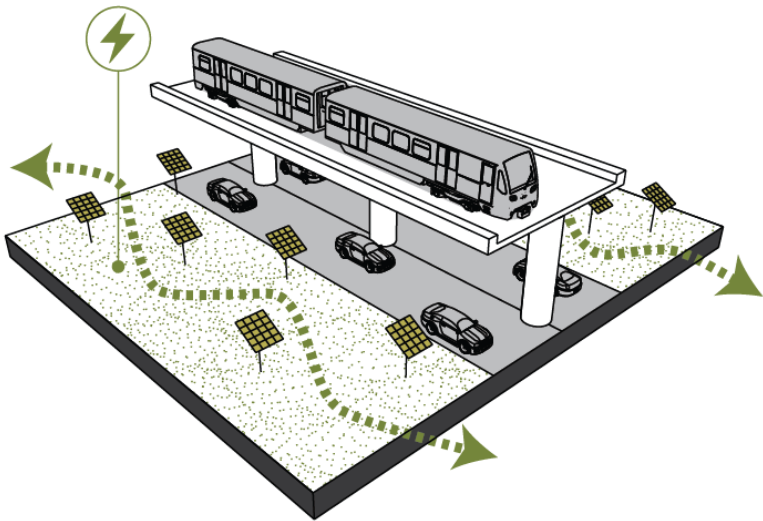
Key



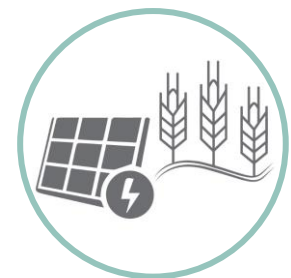
Secondary transit
lines



Incubators linked to a
secondary or primary
transit line



Rethinking “vs energy” as “and energy”: Cross-functional uses with technology



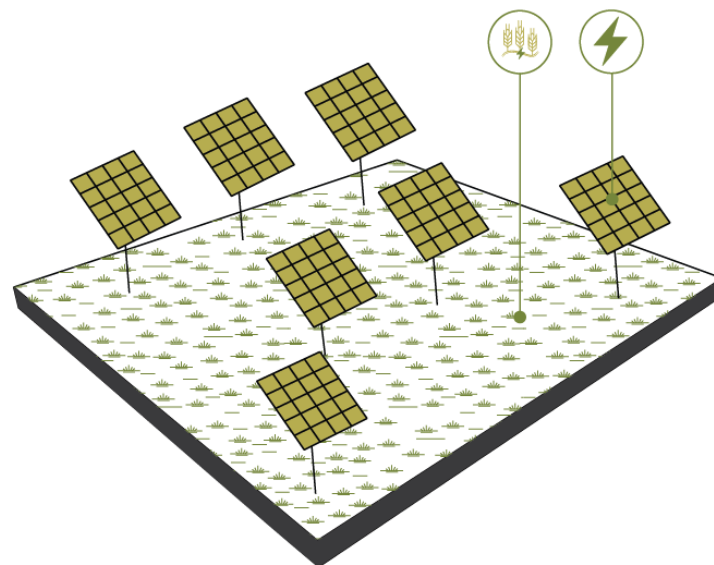
Agri-voltaic system



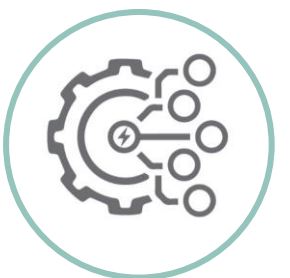
Farming methods



Water harvesting



Update technology

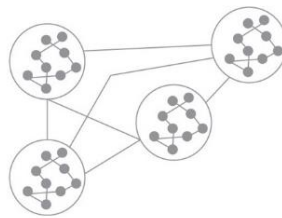
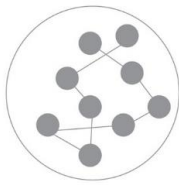
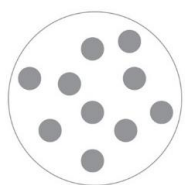


Equipped with CCS

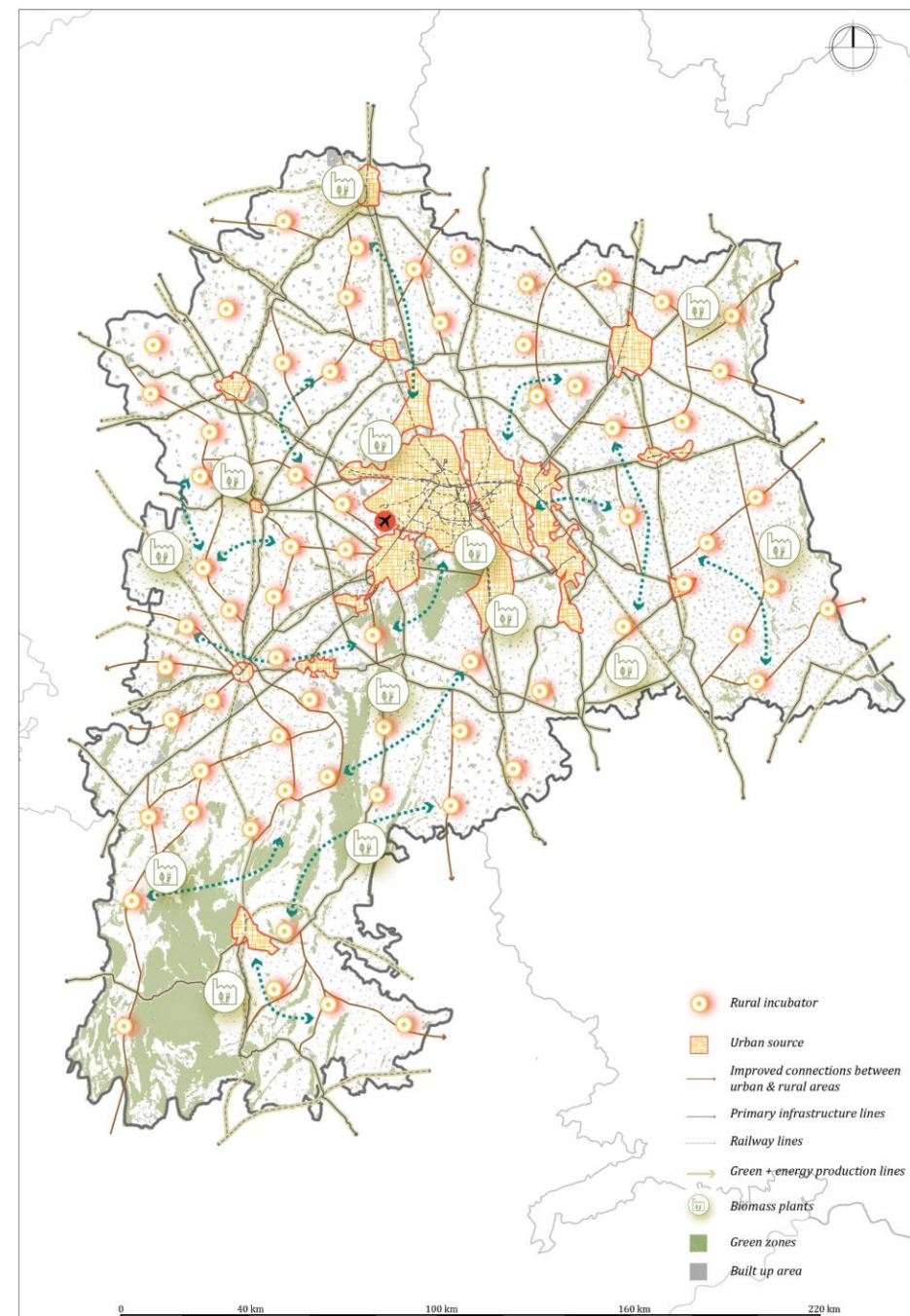


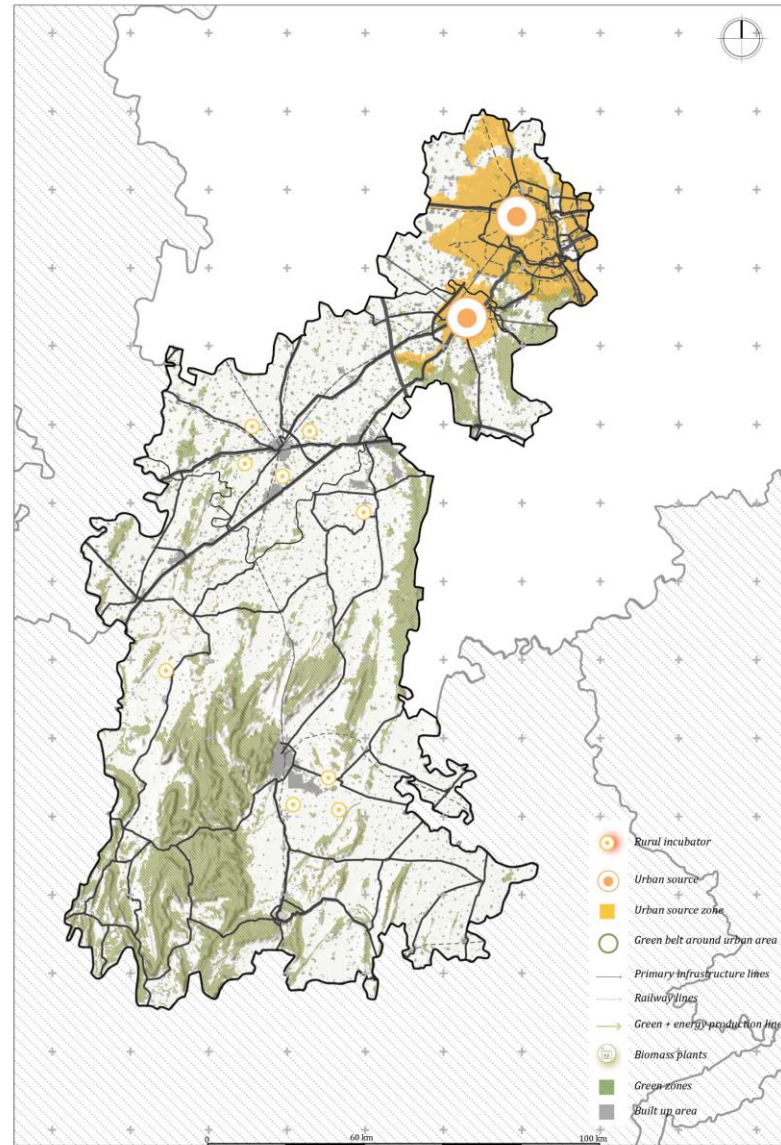
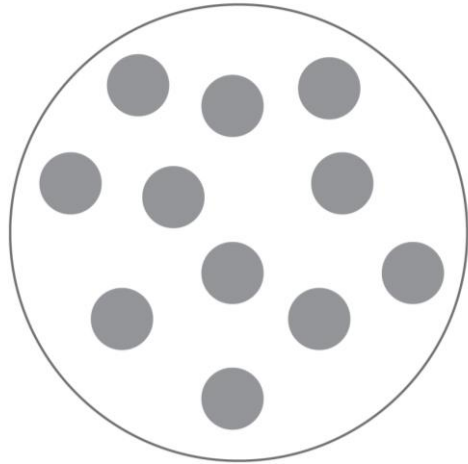
Fuel switching

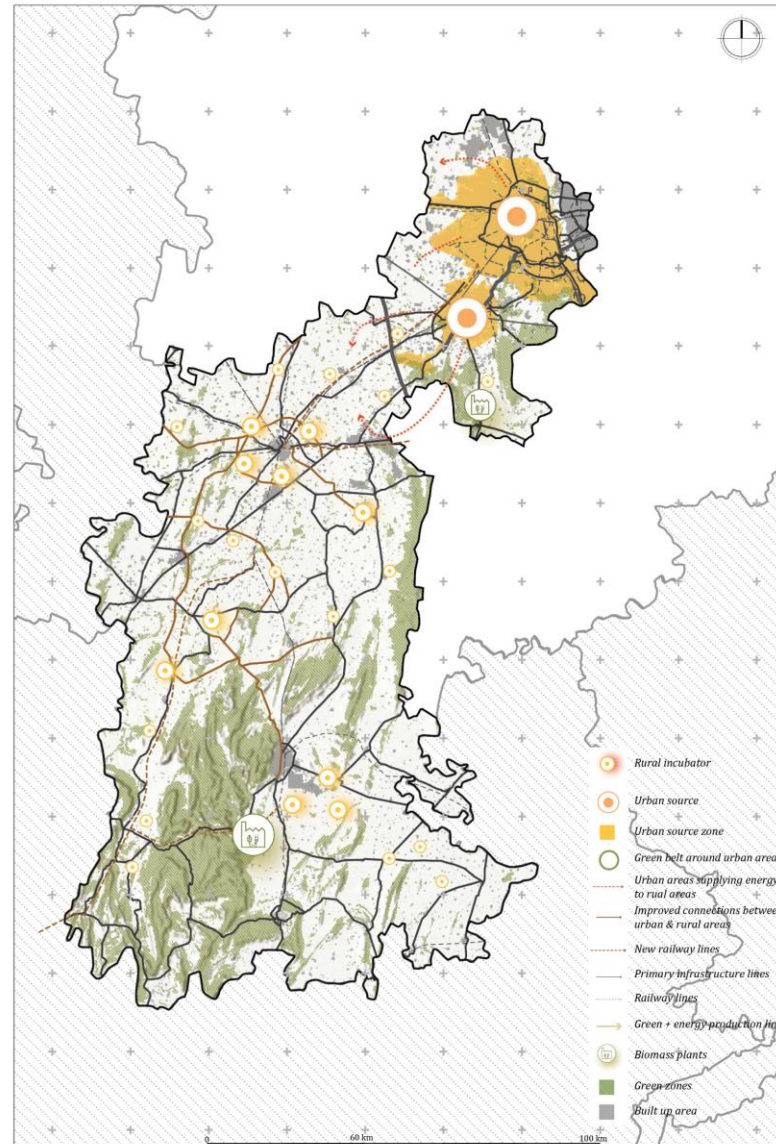
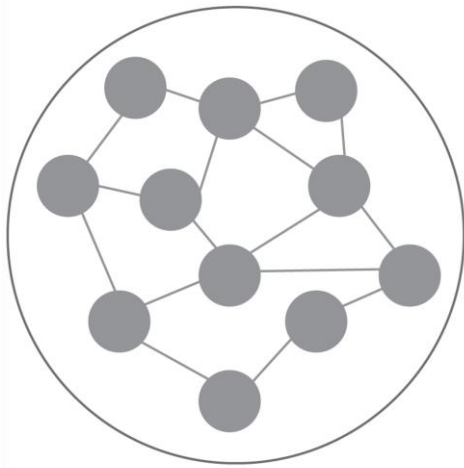


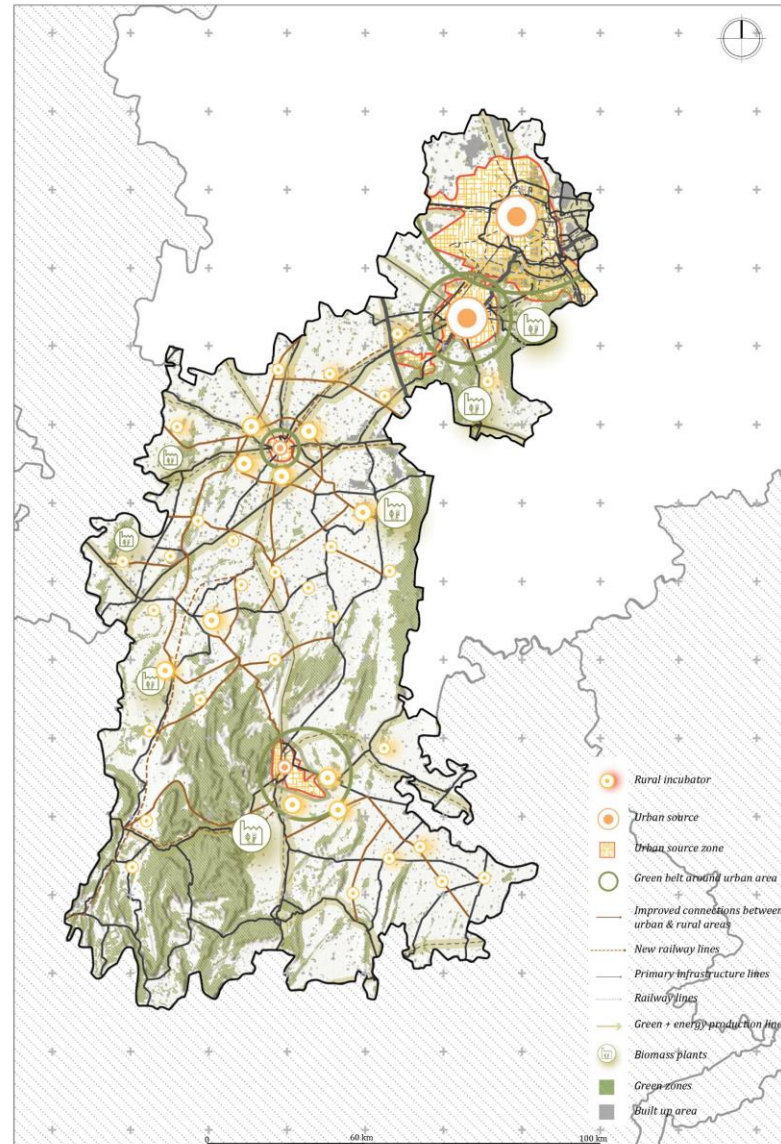
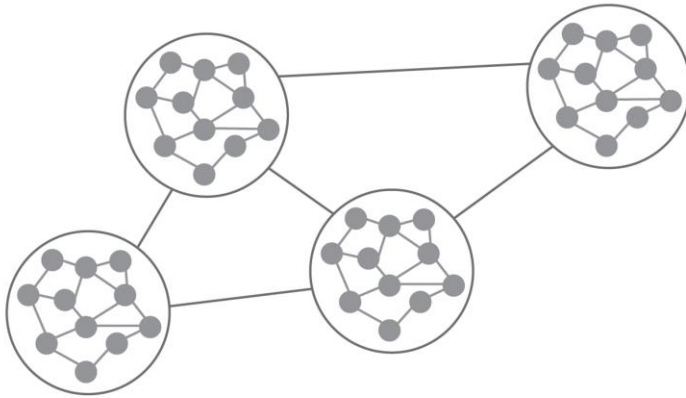


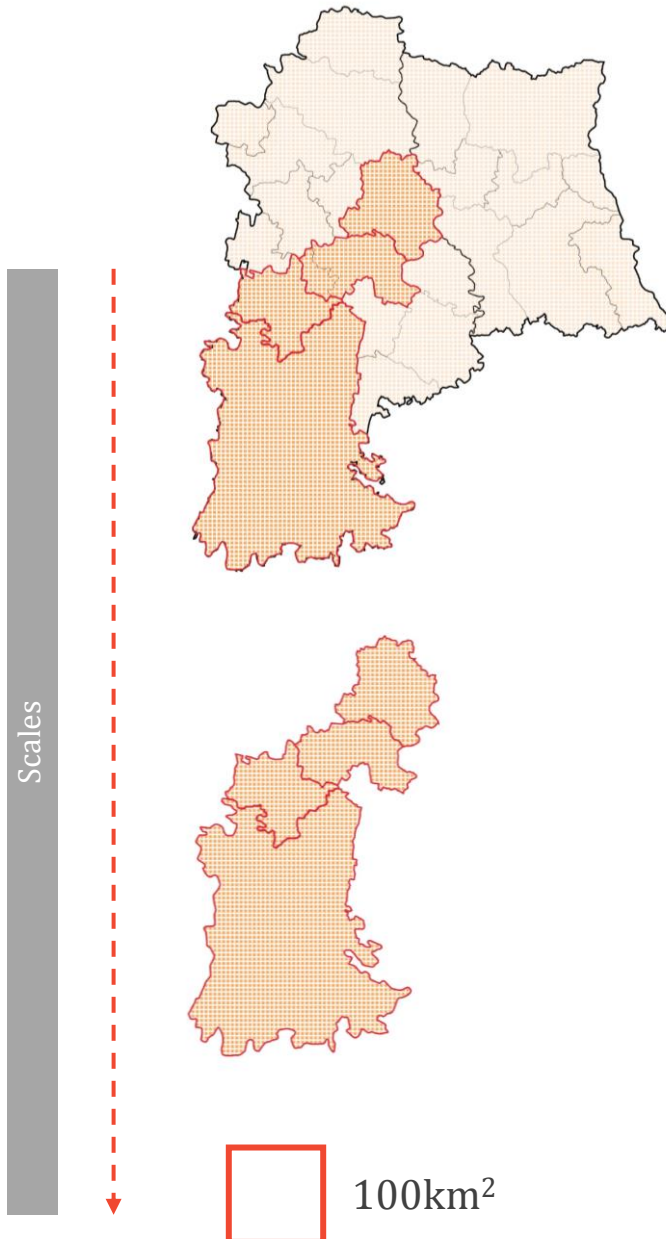
Vision 2051

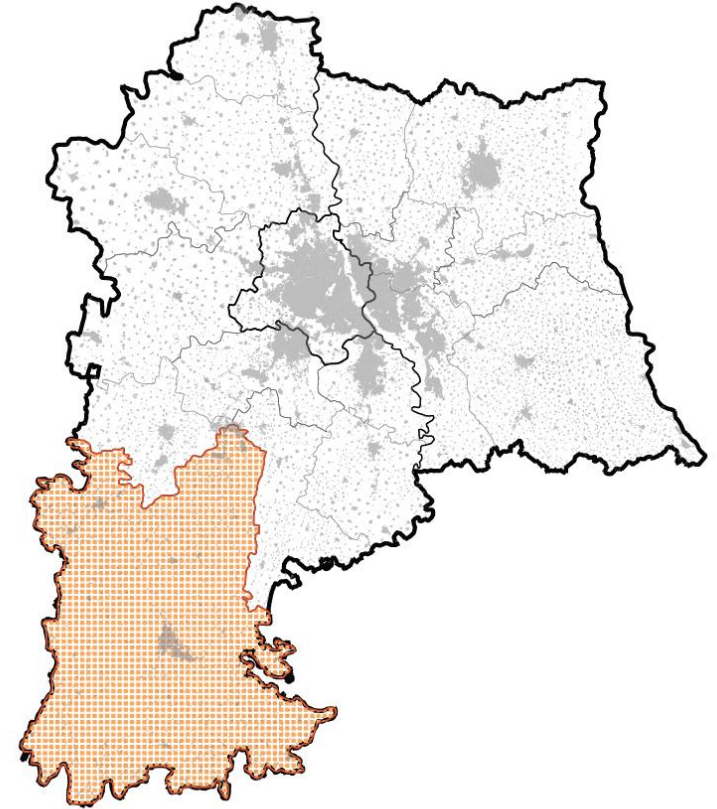


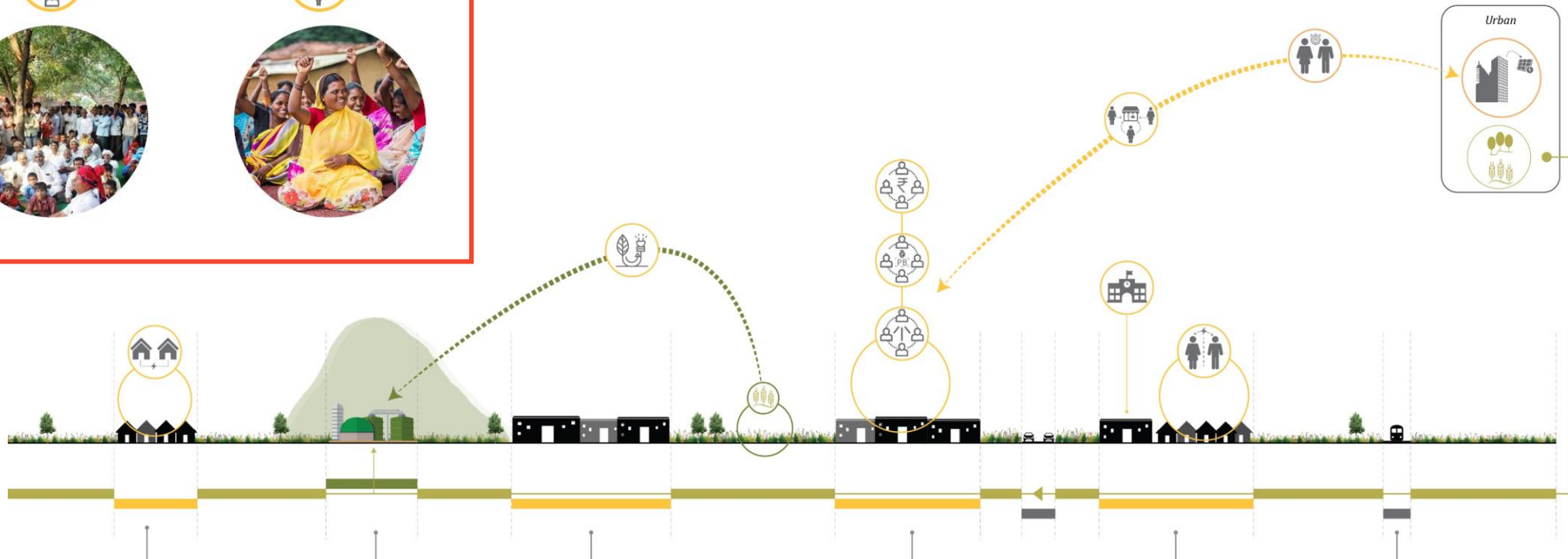










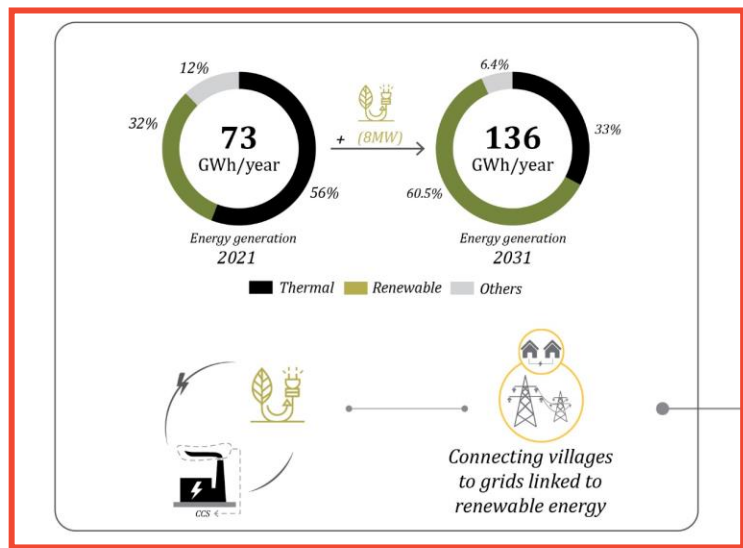


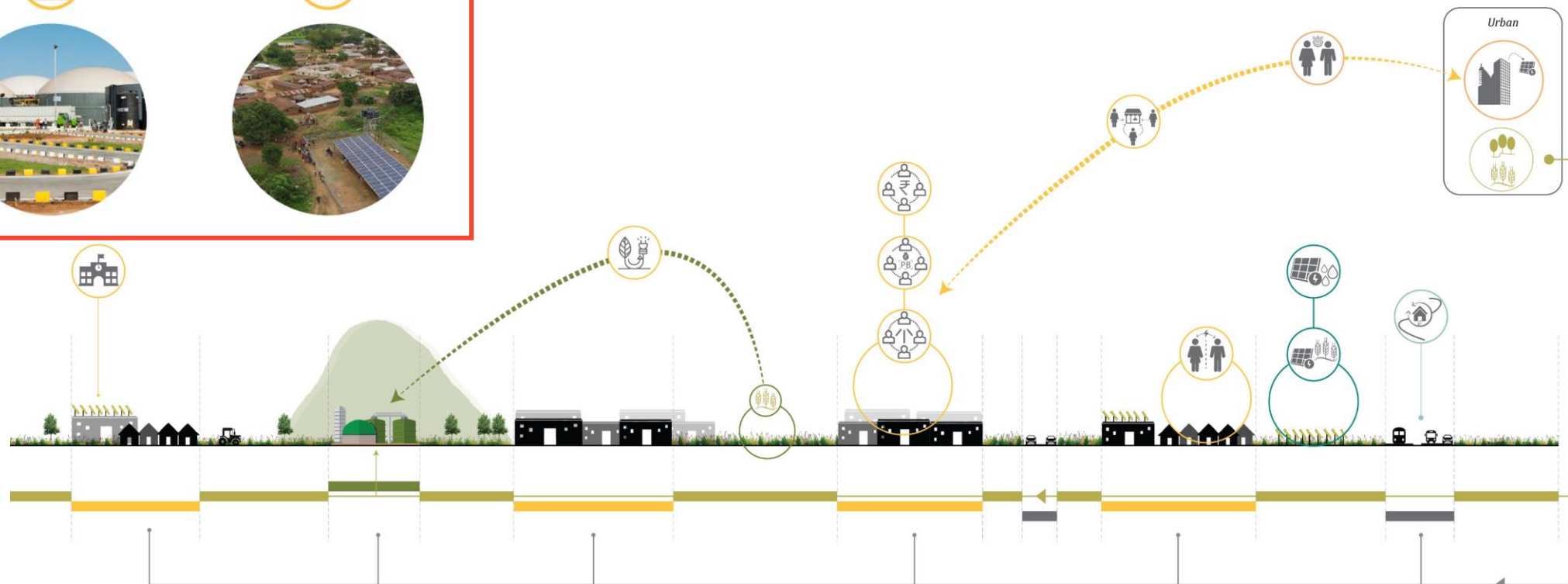
Setting up open source rural incubators: Empowering the rural areas

Extending transit lines to improve urban-rural connectivity

Rethinking “vs energy” as “and energy”: Cross-functional uses with technology

- Biomass power
- Thermal power
- Solar power
- Green residue and other biowastes
- Agricultural waste
- Rural areas
- Energy storage
- Primary building
- Community organisations
- Gender separation to addressing issues
- Setting up open source rural incubators: Empowering the rural areas
- Rural villages
- Transit lines
- Green areas
- R.E
- Economic zones
- Financial aid groups
- Participatory budgeting
- Women based work groups
- Decentralised grids
- Work groups from rural areas
- Shifting the role of dense urban areas: creating an urban source
- Retrofitted with solar panels



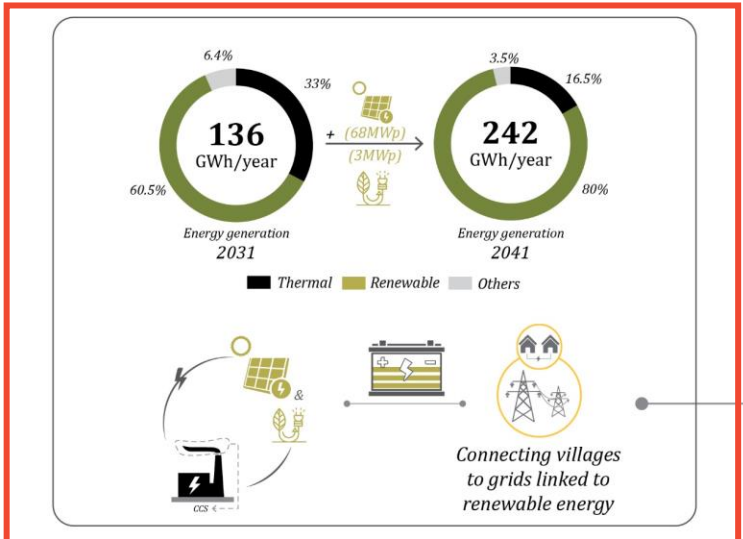


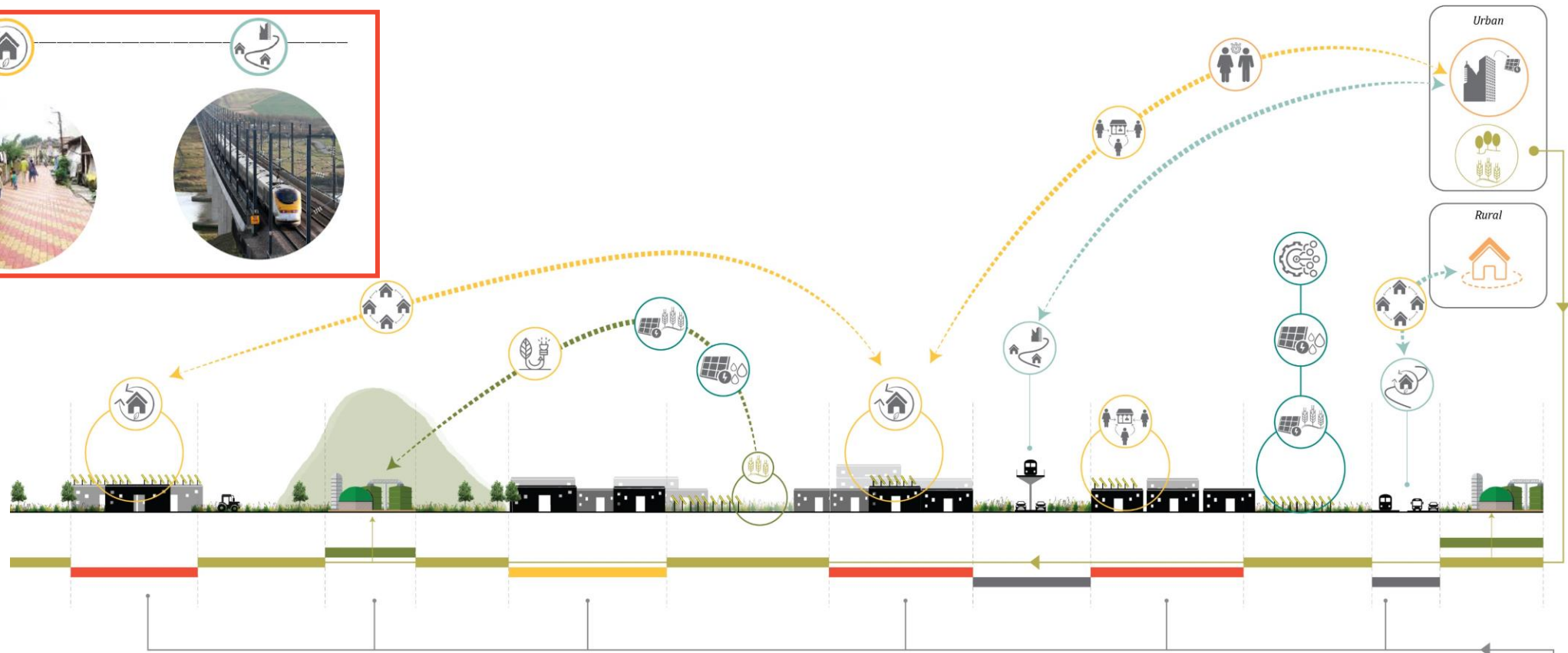
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- Strengthening transit support: improving urban-rural connectivity
- Rethinking 'vs energy' as 'and energy': Cross-functional uses with technology
- Agrivoltaic farming
- Rural incubators linked to transit
- Primary transit lines linked to renewable energy source
- Retrofitted with solar panels
- Women based work groups
- Participatory budgeting
- Financial aid groups



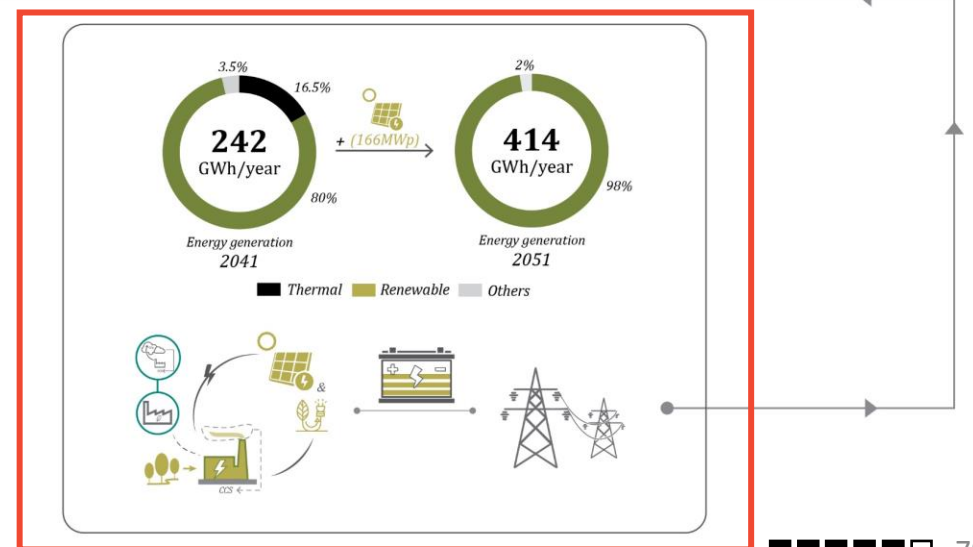


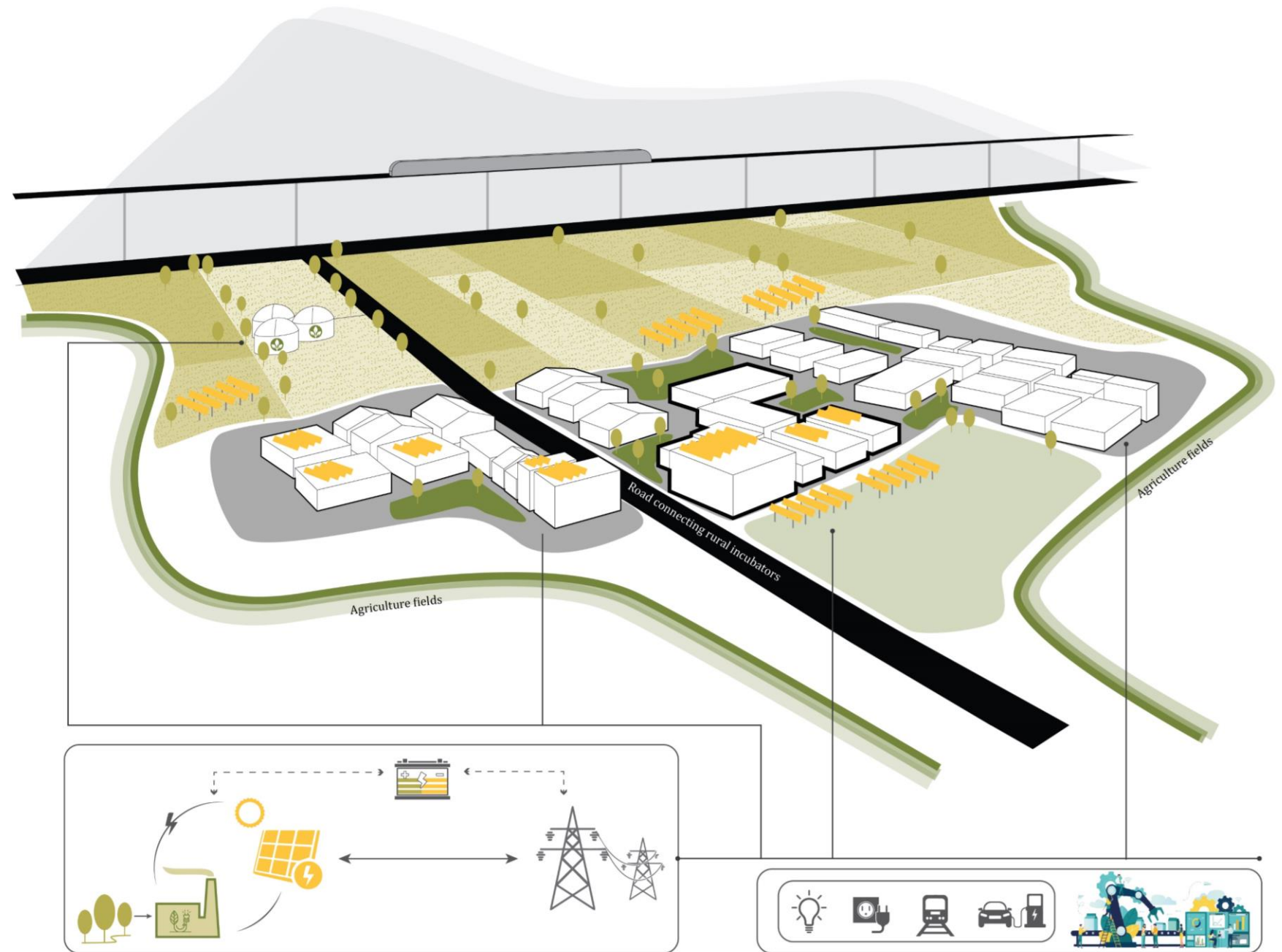
Setting up open source rural incubators: Empowering the rural areas

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Rethinking “vs energy” as “and energy”: Cross-functional uses with technology

- | | | | |
|---|-------------------------|---|---|
| Biomass power | CCS technology | Technology updates | Downsizing and fuel switching |
| Thermal power | Rural villages | Water harvesting | Agrivoltaic farming |
| Solar power | Transit lines | Strengthen secondary transit lines | Rural incubators linked to transit |
| Green residue and other biowastes | Green areas | Work groups from rural areas | Primary transit lines linked to renewable energy source |
| Agricultural waste | R.E | Knowledge & resource exchange | Retrofitting with solar panels |
| Rural areas | Economic zones | Decentralised grids | Rural incubator |
| Energy storage | Financial aid groups | Shifting the role of dense urban areas: creating an urban source | |
| Primary building | Participatory budgeting | Strengthening transit support: improving urban-rural connectivity | |
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Setting up open source rural incubators: Empowering the rural areas

Extending transit lines to improve urban-rural connectivity

Rethinking “vs energy” as “and energy”: Cross-functional uses with technology





Shifting the role of dense urban areas:
creating an urban source

Extending transit lines to improve
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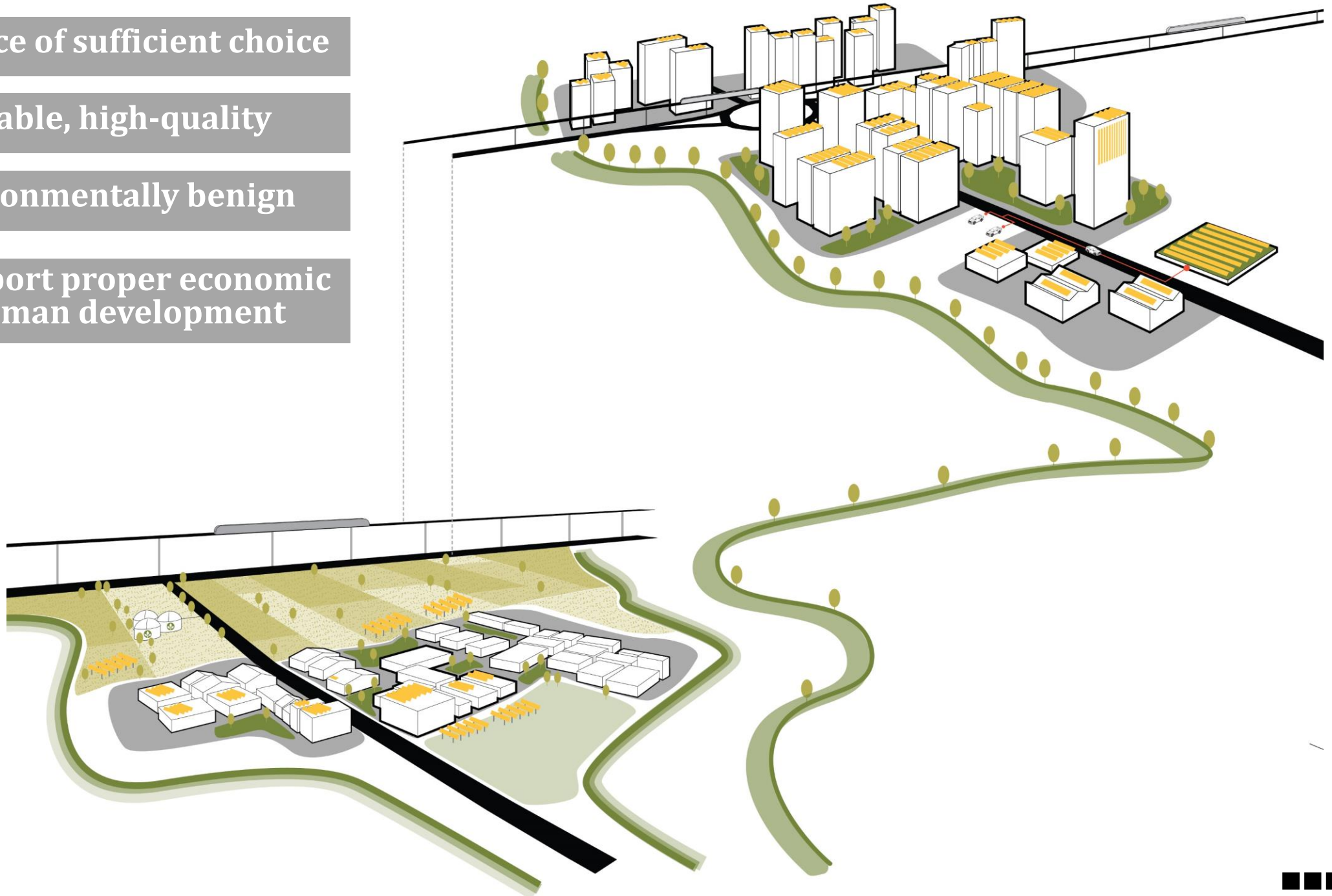
How can a regional energy system between urban and rural areas be designed for a just renewable energy transition in NC region, India ?

Presence of sufficient choice

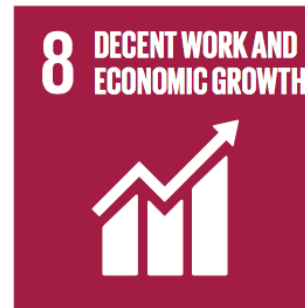
reliable, high-quality

environmentally benign

To support proper economic
& human development



SUSTAINABLE DEVELOPMENT GOALS



Limitations

- Limited access to accurate logistical data of the rural areas made it difficult to accurately analyse the areas with energy vulnerability.
- Energy poverty has both electricity and fuel based poverty in its umbrella. This project considers only electricity production and consumption.
- The project does not take into consideration whether the production of the energy resources like solar panels are made in a sustainable manner.
- This project looks only at the impacts of energy on the food and water system and not at the inter-relations between the FEW systems.



ACCESS TO

ELECTRICITY

(% OF POPULATION)

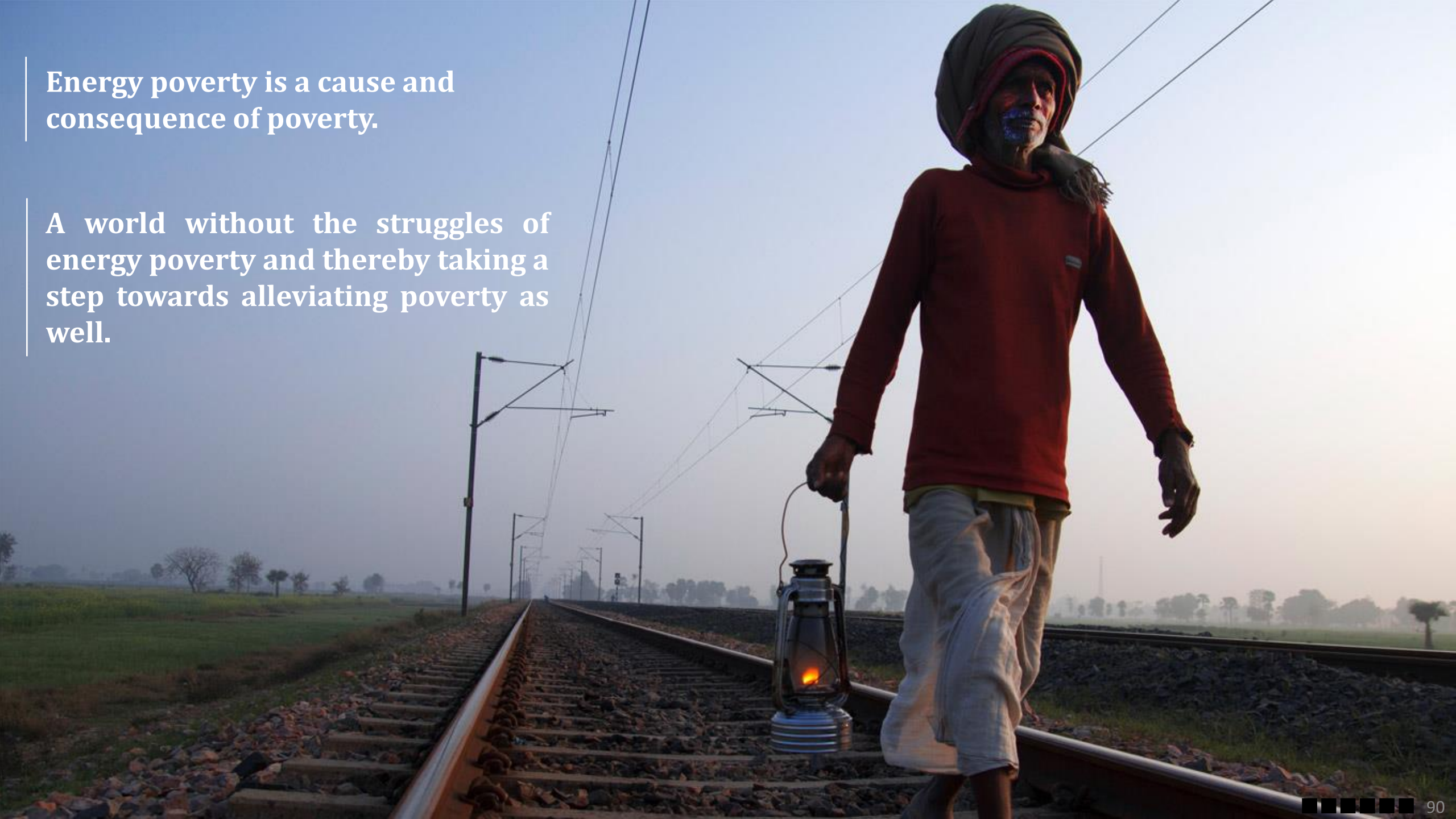


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Data source: The World Bank www.worldbank.org

Energy poverty is a cause and consequence of poverty.

A world without the struggles of energy poverty and thereby taking a step towards alleviating poverty as well.





Thank you !