INTEGRATED APPROACH TO ENVIRONMENTAL PLAN WITH FOCUS ON SOLAR ENERGY, CASE STUDY SHIMLA

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INTRODUCTION

2012 has been declared as International Year for Sustainable energy by United Nations.

Development needs to be aligned with **sustainability**;

Renewable energy is one such step…..

Planning initiatives to mainstream **renewable/ solar energy** concerns into development planning process.

Jawaharlal Nehru National Solar Mission launched on the 11th January, 2010 by Ministry of New and Renewable Energy with ambitious target of deploying 20,000 MW of **grid connected solar power by 2022** and is aimed at **reducing the cost** of solar power generation.

Mission will create an enabling **policy framework** to make India a **global leader in solar energy.**

INTRODUCTION

Current study ‘Environmental Plan for Shimla with focus on solar energy 2021’ focuses to

understand,

analyze,

synthesize and

strengthen

city capacity to address these challenges at **national, local and community levels**,

Providing **innovative proposals** and linking through **pilot projects** that help cities to **build sustainable livelihoods.**

Study assesses the manner in which **energy consumption varies** across different land uses and ecological settings.

STUDY AREA, SHIMLA PLANNING AREA

Shimla, multifunctional city with **dominance of tourism**, three tier **administration** [state, district and city] and i**nstitutional** activities.

Central Shimla is **over-congested and crowded, exploited above natural carrying capacity.**

Locals recall **massive deforestation of sunny slopes** in past 3 decades to accommodate service population, administrative requirements, tourism etc.

Snow spells now concentrate in special area of Kufri and its vicinity to Shrikhand ranges and further higher altitude.

Study area is 100 Sq. km comprises of Shimla Planning area, which includes municipal area and three special areas, namely, Kufri, (predominantly tourist destination), Shoghi and Ghanahatti.

STUDY AREA, SHIMLA PLANNING AREA

Topographical structure is **rolling terrain gentle to steep slopes in seven hill spurs** dominating the landscape.

As per census 2011 population of Shimla Planning Area is 207848 and the projected population for year 2021 was assigned to be 260000.

MC Shimla at present houses **82% of population and has only 22.2% of land parcel**.

Expanding Shimla over the Time

Massive Construction at Cemetery without Proper Accesses

VISION, AIM & OBJECTIVES

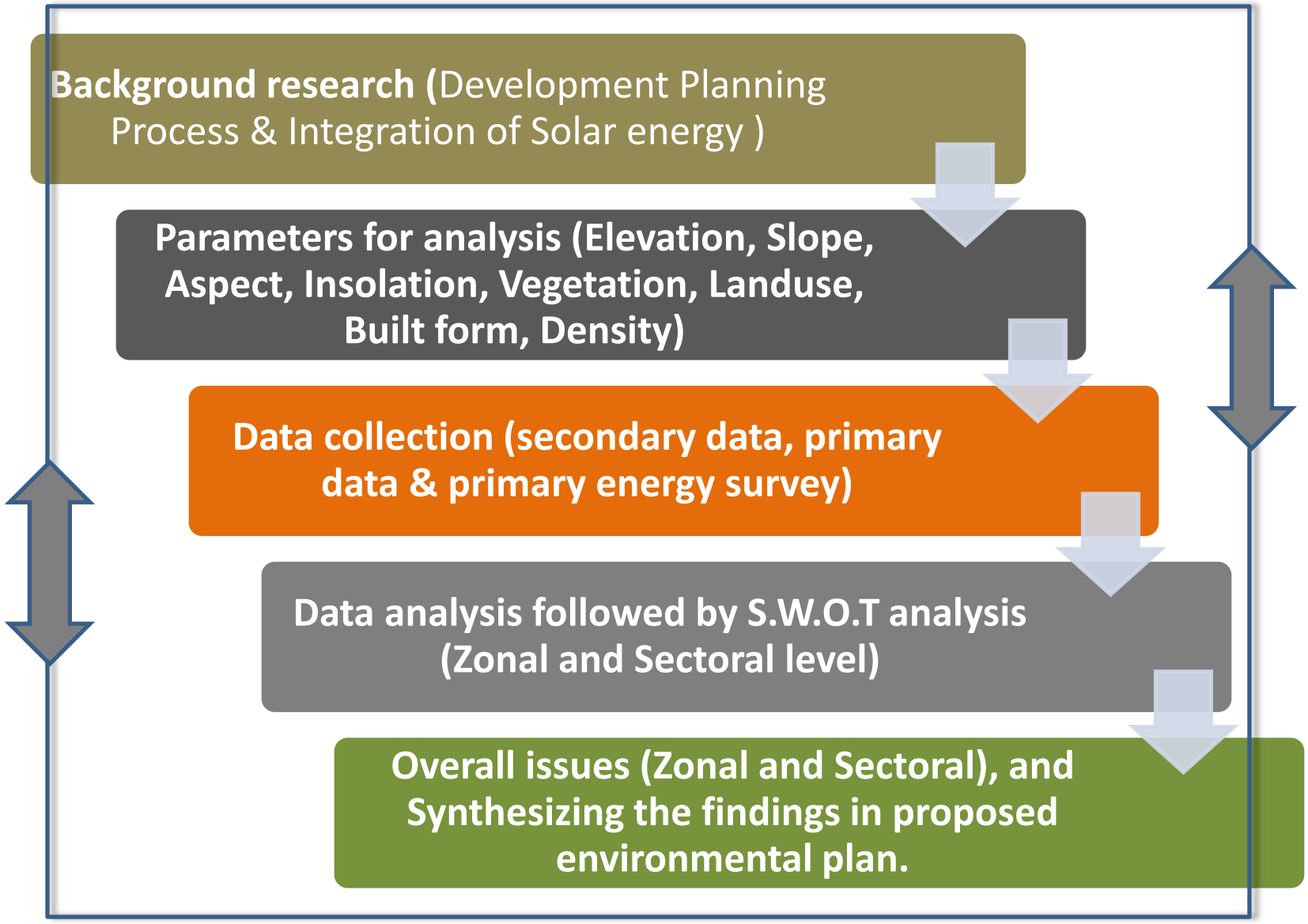
Vision statement for Shimla 2021: Achieve sustainability by promoting a civil society which consumes less energy, efficiently and is willing to switch over to renewable sources - primarily Solar energy, and by mainstreaming energy efficiency measures and usage of solar energy in development planning process.

Aim of the study: To formulate the environmental plan for sustainable development of Shimla.

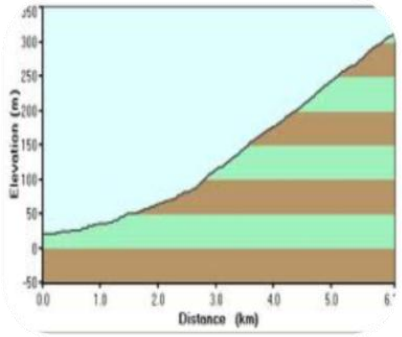
The objectives of the study were:

To reduce dependence on conventional and non-renewable sources.
To identify measures for energy efficiency.
To analyze the relationship between physiography and energy consumption.
To integrate new and renewable energy systems with the development planning process.

METHODOLOGY

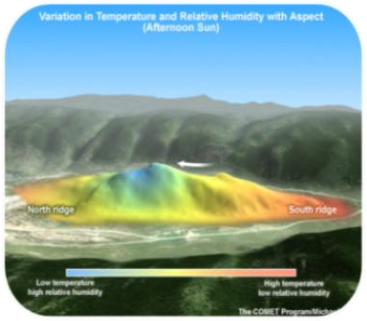


PARAMETERS FOR ANALYSIS

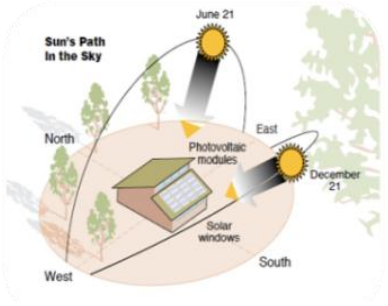


Elevation

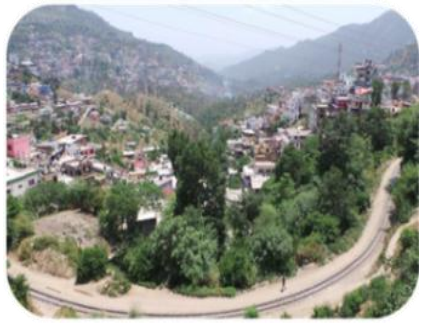
Slope



Aspect



Insolation



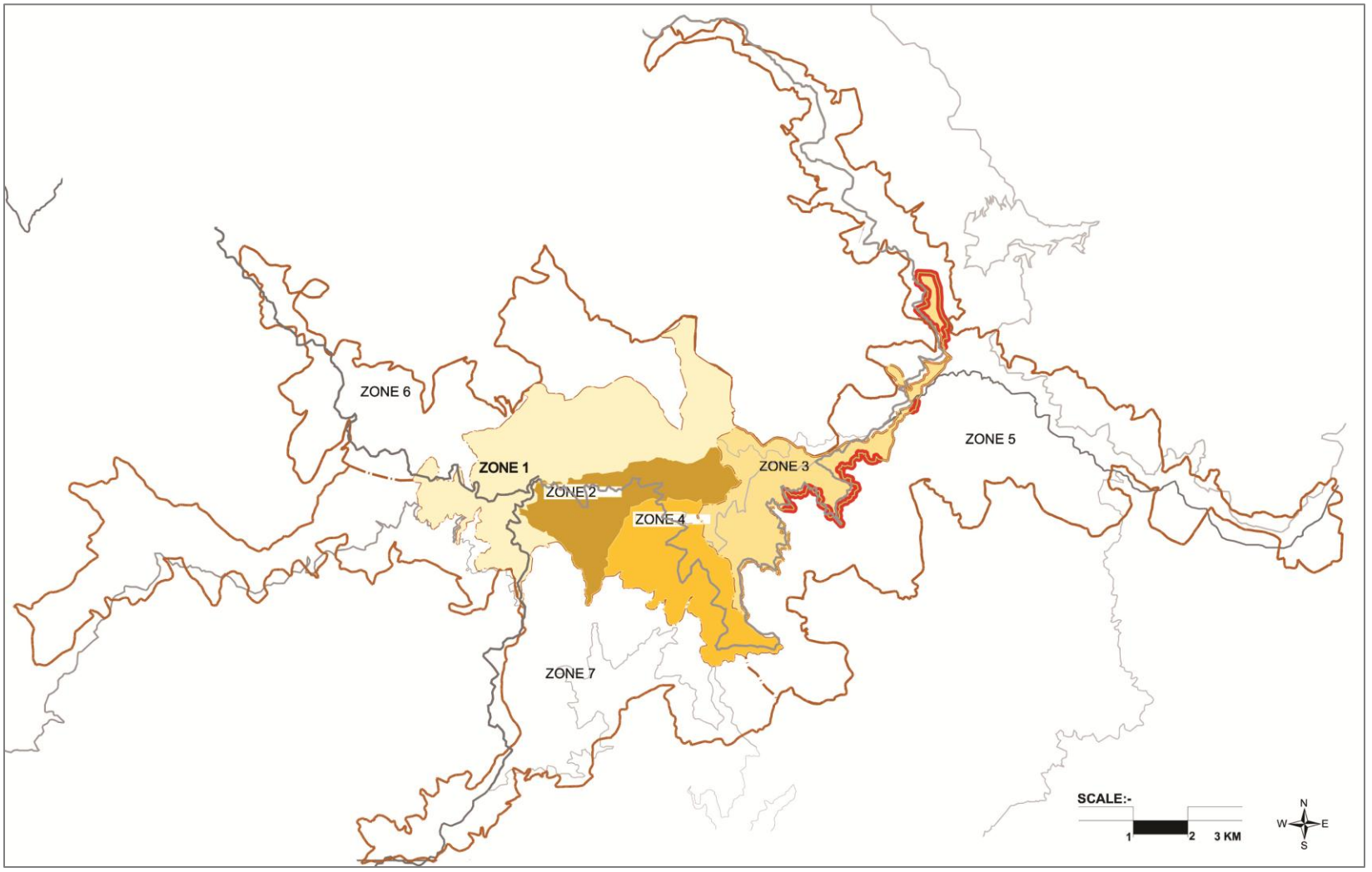
Vegetation

Land Use

Built Form

Density

ZONAL SPATIAL ANALYSIS FOR SHIMLA PLANNING AREA



Zonal Spatial Study Areas, Shimla Planning Area

Source: Prepared for the Study Spring 2014

Spatial S.W.O.T analysis was done to identify **areas suitable for future development** and **areas conducive for harnessing solar energy**. Study area was divided on basis of population and physical contiguity into 7 spatial zones

ZONAL SPATIAL ANALYSIS FOR SHIMLA PLANNING AREA

Zone No.	Ward No.	Area (Ha.)	Population (Nos.)	Altitude above MSL (m)	Predominant Slope	Predominant Aspect	Predominant Land Use	Gross Density (pph)	Net Residential Density (pph.)
1	1,2,3,4,5,6,7	1115.1	43016	1600-2300	50-60%	N, S & NW	Residential and Agricultural	39	222
2	8,9,10,11,12,13,14	473.2	32909	2000-2200	50-60%	S, SE & SW	Residential and Forest	70	390
3	15,16,17,18,19,20	620.9	42548	1600-2400	30-40%	SE	Forest and Residential	69	333
4	21,22,23,24,25	526.5	51045	1600-2000	10-30%	W & SW	Agricultural and Residential	97	285
5	Khufri	3173	12748	2000-2700	30-40%	S & SW	Forest and Agriculture	4	64
6	Ghanahatti	1647	12111	1200-1800	60-100%	SW, SE & NE	Forest and Agriculture	7	71
7	Shoghi	2923	13471	1200-1900	10-30% & 30-40%	SW & S	Forest and Agriculture	5	95

Zonal Spatial Characteristics, Shimla Planning Area

Source: Census 2011, Draft Development Plan Shimla 2021 & Primary Energy Survey for the Study Fall 2014

ZONAL SPATIAL ANALYSIS FOR SHIMLA PLANNING AREA

Zone	Strength	Weakness	Opportunities	Threats
1	Predominant aspect is S (152 Ha), where majority of development has taken place: **feasible for integration with Solar energy harnessing** measures	**Majority of land use as forest** (67%) which cannot be added for any kind of development. Predominant slope (50% to 60%), energy stress on maneuvering and travelling.	Favorable slopes (below 40%), majority of agricultural land (146.7Ha) in which **area can be proposed for development**.	62% (597.8 Ha) of area under unfavorable slope range (above 40%) which restricts from developing. Existing development are **vulnerable to hazards** like earthquake and land slide.
2	Predominant aspect is S, SE & SW (330 Ha) **conducive for harnessing solar energy**.	Predominant slope is 50-60% unfeasible for settlement, 244 Ha **covered by forests**, restricting spatial growth.	Significant proportion of Commercial and PSP land use: energy intensive activities: **enhance feasibility of solar energy**	82% of existing built up falls in slope range of 50-60% : making it vulnerable to natural disasters - **hazard prone areas**

Zonal Spatial S.W.O.T analysis and issues

Source: Draft Development Plan Shimla 2021 & Primary Energy Survey for the Study Fall 2014

ZONAL SPATIAL ANALYSIS FOR SHIMLA PLANNING AREA

Zone	Strength	Weakness	Opportunities	Threats
3	Predominant aspect is SE & E; existing development has also taken place along these aspects.	Predominant Slope is 39% although significant proportion of feasible slope is present; forests occupy maximum area **restricting further development and spatial growth**.	Significant area of Forest and residential land use: residential area has energy intensive activities: **feasible for harnessing solar energy.**	48% area under hazard prone, which is not feasible for development.
4	Predominant aspect is SW (30%) & W (52%) where development has taken place.	**Only 12% (58.6 Ha) of area falls under S aspect**. Ward 25 has majority of landuse as forest cover which cannot be used for development or harnessing solar energy.	6% (35.5 Ha) is PSP land use with S & SW aspect, **opportunity for centralized harnessing units**. Favorable slopes (below 40%) have agricultural land (135.6 Ha) which can be proposed for development.	47% (255.5 Ha) of area under **unfavorable slope** (above 40%) which restricts from developing. Existing development in those areas are vulnerable to hazards like earthquakes and landslides.

Zonal Spatial S.W.O.T analysis and issues

Source: Draft Development Plan Shimla 2021 & Primary Energy Survey for the Study Fall 2014

ZONAL SPATIAL ANALYSIS FOR SHIMLA PLANNING AREA

Zone	Strength	Weakness	Opportunities	Threats
5	Predominant aspect is S, SE & SW 1433 Ha of hill slope falls under these aspects.	70 % of landuse is of forests, thus **restricting development** along certain areas.	Predominant slope is 30-40% (780Ha) suitable for future growth and development	Forests as necessity to maintain ecological balance of region, **thus these zones are fragile**. Development needs to integrate natural heritage as it is.
6	Predominant aspect is S & SE available across 300 Ha.	60 % of landuse is of forests, thus **restricting development** along certain areas.	30 - 40% slope occupies 21% of land area providing scope for future development	
7	S, SW & SE aspect is available across 1433 ha.	60 % of landuse is of forests, thus **restricting development** along certain areas.	10-30 % slope occupies 31% of land area providing scope for future development	

Zonal Spatial S.W.O.T analysis and issues

Source: Draft Development Plan Shimla 2021 & Primary Energy Survey for the Study Fall 2014

ZONAL SPATIAL ANALYSIS FOR SHIMLA PLANNING AREA

Zone	Issues
1	Building heights and **close proximity of buildings lead to less solar exposure**. Buildings have been built on hazardous slope i.e. above 40%. **Environmental degradation** in form of changes in micro climate, loss of vegetation cover, disturbance to hydrological regimen, pollution and increase occurrences of instability is witnessed along with increased building construction activity.
2	Consists of slum pockets with **dilapidated structures and close proximity of buildings, reduces solar exposure**, needs to be addressed separately. Presence of significant proportion of built heritage i.e structures which cannot be considered for retrofitting with solar devices. Existing built up on 50-60% slope using cut and fill exposes built up areas and inhabitants to disasters.
3	Construction is **high density medium rise on southern slopes, can be integrated for harnessing solar energy.** Unplanned construction prior to addition of these areas into MC Shimla has lead to inadequate physical and social infrastructure facilities. These residential parcels are resultant of administrative zones of Sachivalaya in proximity.

Zonal Spatial issues

Source: Draft Development Plan Shimla 2021 & Primary Energy Survey for the Study Fall 2014

Zone	Issues
4	Height restrictions (max permissible height 18.8m) are in force throughout the town irrespective of slope, aspect and location which leads to high density development without considerations for infrastructure and other facilities. Certain areas fall on **100% shadow due to proximity of buildings and slope,** which directly influences increase in energy requirements. Less road width, mostly 3m- causes congestion, traffic jams and other related problems. **Cut and fills** has totally changed natural profile of region, it affects natural drainage.
5, 6, 7	Predominant **rural settings with dispersed built up masses**, connectivity and infrastructural services will have to be enhanced while considering future growth. **Solar farms** can be proposed on southern aspects falling on favorable slopes. Tourist destinations such as Kufri are **functioning beyond the carrying capacity.**

Zonal Spatial issues

Source: Draft Development Plan Shimla 2021 & Primary Energy Survey for the Study Fall 2014

SOLAR ZONING FOR SHIMLA PLANNING AREA

Present study was focused on **integration of energy consumption and production with spatial planning**; efficient and effective land use as probable solution to clean and green energy.

Findings from primary energy survey done in February 2014 shows **energy demand per capita per annum as 25% lower in southern aspects** when compared to eastern-western aspects.

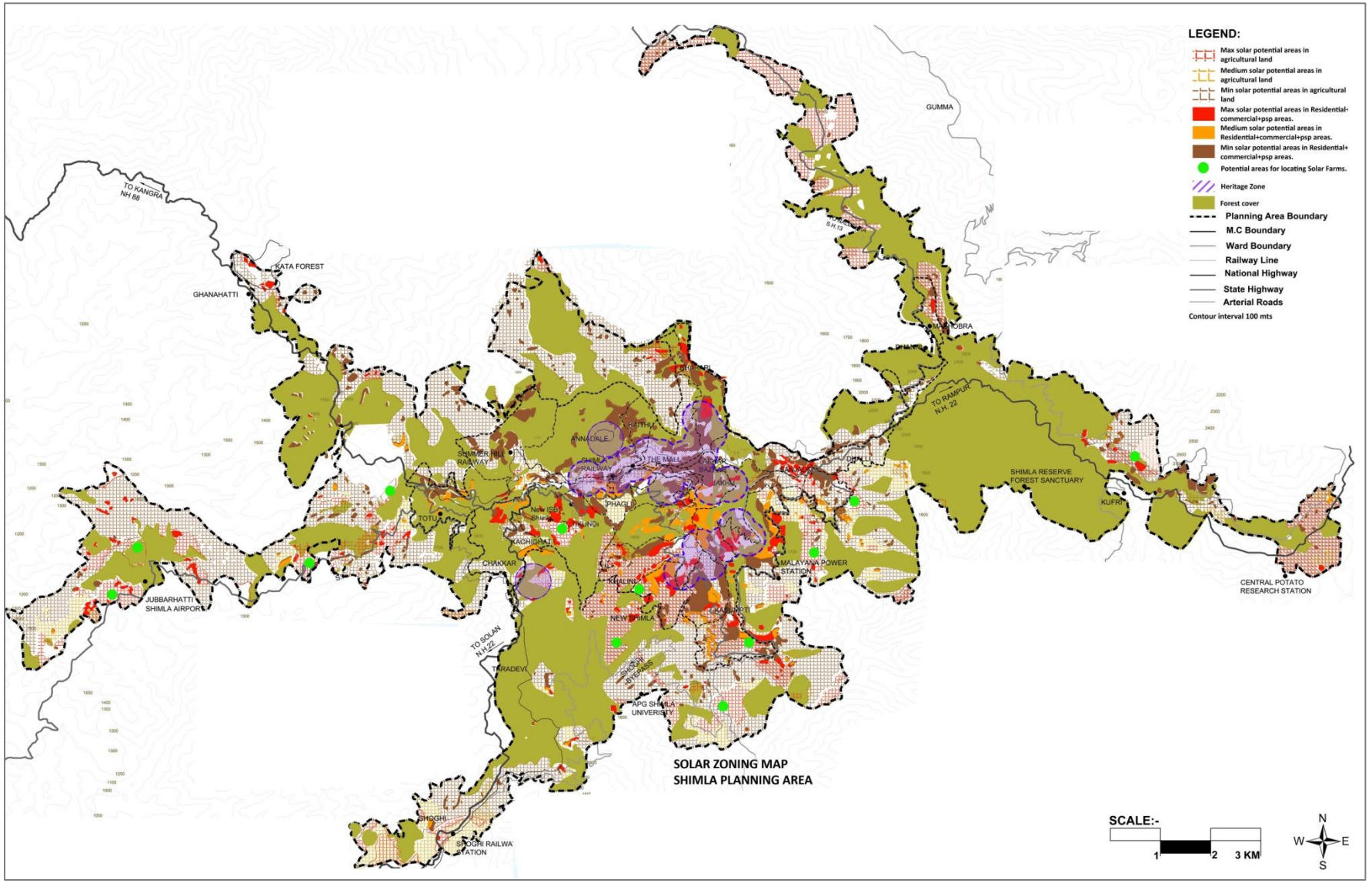
Consumption of electricity and other sources of energy increase because space and water heating demand drastically **increase during winter season** every year (November-April).

S, SE, SW aspect and slope 0-30% **areas were marked as zones where SPV installations** can be incorporated both on roof tops and front facades. Side facades are left out, since sufficient setbacks for installing devices are not available.

E, W aspect with 30-40% are marked as zones to install SPV installations on roof.

N, NE, NW aspect with slope above 40% cannot be zoned for any solar device installations.

ZONAL SPATIAL ANALYSIS FOR SHIMLA PLANNING AREA



Solar Zoning Map, Shimla Planning Area

Source: Prepared for the Study Fall 2014

Energy Plan

for horizon year 2021; energy demand projected taking into account **25% decadal growth**. **Residential sector consumed 61% of Electricity**. Lighting, water heating and space heating consumes 70% of electricity energy in residential sector.

Average annual values of consumption were arrived for different sectors. For commercial, consumption was considered for Shops as well as tourism industry, energy consumed in both these sub-categories vary. For PSP sub categories were Educational buildings, Health care buildings, Government buildings, and Other-Socio cultural buildings.

Energy Projection for 2021

In the decade 2001 to 2011, growth rate per household/ per sq.m of built space has been 25%. Energy consumption for year 2021 is expected to be 25% higher than the consumption in 2011.

Energy conservation and alternate sources

In a household, lighting accounts for 20% of total electricity consumption, and 30% in commercial and institutional buildings.

SCENARIO 1:

Reduction of dependence on conventional energy sources by adopting energy efficient lighting and SPV roofs were analyzed.

Replacing one light in every household with LED lights, energy consumption per household **reduced by 18%.**

In commercial and institutional sector, 50% of lights when replaced with LED lights energy **consumption reduced** by 8.5% and 12% respectively.

SCENARIO 2:

Reduction of dependence on conventional energy sources by **adopting energy efficient lighting and SPV roofs and solar farms** was analyzed.

Replacing all lights in each of the sectors with LED lights, substantial reduction in energy consumption was achieved. Reduction accounted for 27% in Residential,
17.1% in Commercial and
24% in Institutional sector.

Solar Farms in an area of 100 Ha were proposed **to offset energy consumed by Water supply and Waste water treatment**. 20% of Land for circulation, 80% of land area available for mounting solar panels. When panels are mounted at an angle of 33^0, surface area available is 1.2 times than the flat area.

Adopting **Energy efficient lighting, SPV roofs and solar farms**, total dependence on Conventional energy sources had **proposed reduction by 111.2%**. In this scenario **generation of energy exceeds consumption by 11%.**

INTEGRATION OF LANDUSE AND SOLAR ZONING

To conserve natural flow of water, **no construction zones along valleys**. Along the acquifer of water flow natural buffers of trees, shrubs and plants were proposed.

Check dams were proposed to cut velocity of water and to augment ground water recharge.

Eco tourism and adventure tourism promoted at Kufri having surface connectivity via NH-88, land availability to enhance tourism, to abate tourism congestion in central Shimla.

Mandatory installation of SPV on roofs, rain water harvesting measures in hotels.

Adoption of EE lights, LED in all sectors in order to cut down energy demand.

INTEGRATION OF LANDUSE AND SOLAR ZONING

There were no active recreational spaces/ parks for children,

Shimla Planning Area has 40% of land area as forests, parks could be integrated in such open areas.

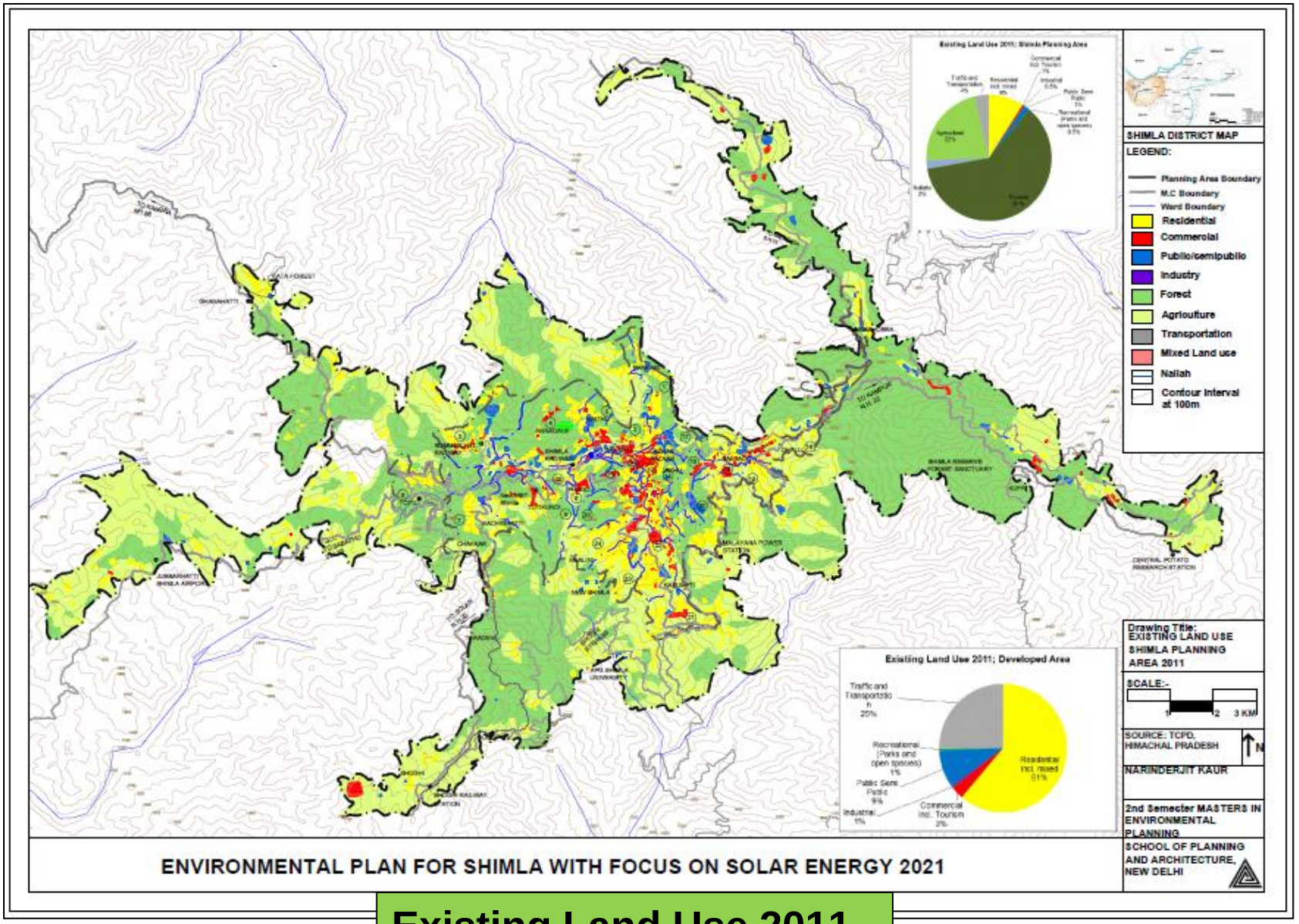
To cater for needs of population in 2021, three 500 bed hospitals were proposed in New Shimla, Ghanahatti and Tutu, as health facilities were lacking in these areas.

Missing links in the sewage network to be connected and worn out lines replaced.

Water supply network and sewage treatment plants require augmentation to meet demand of 2021.

To minimize disposal of solid waste in valleys and water channels, segregation of waste at source prior to collection should be implemented.

STUDY AREA, SHIMLA PLANNING AREA



Existing Land Use 2011

SHIMLA PLANNING AREA, PROPOSED LANDUSE

Environment layers of **analysis w.r.t vulnerability and suitability such as slope, aspect, soil, hydrology, vegetation, wildlife & cultural resources etc.**

Analysis were mapped, overlaid to prepare comprehensive vulnerability map, comprehensive suitability map. **It was assumed that least vulnerable parcel is highly suitable parcel for development.**

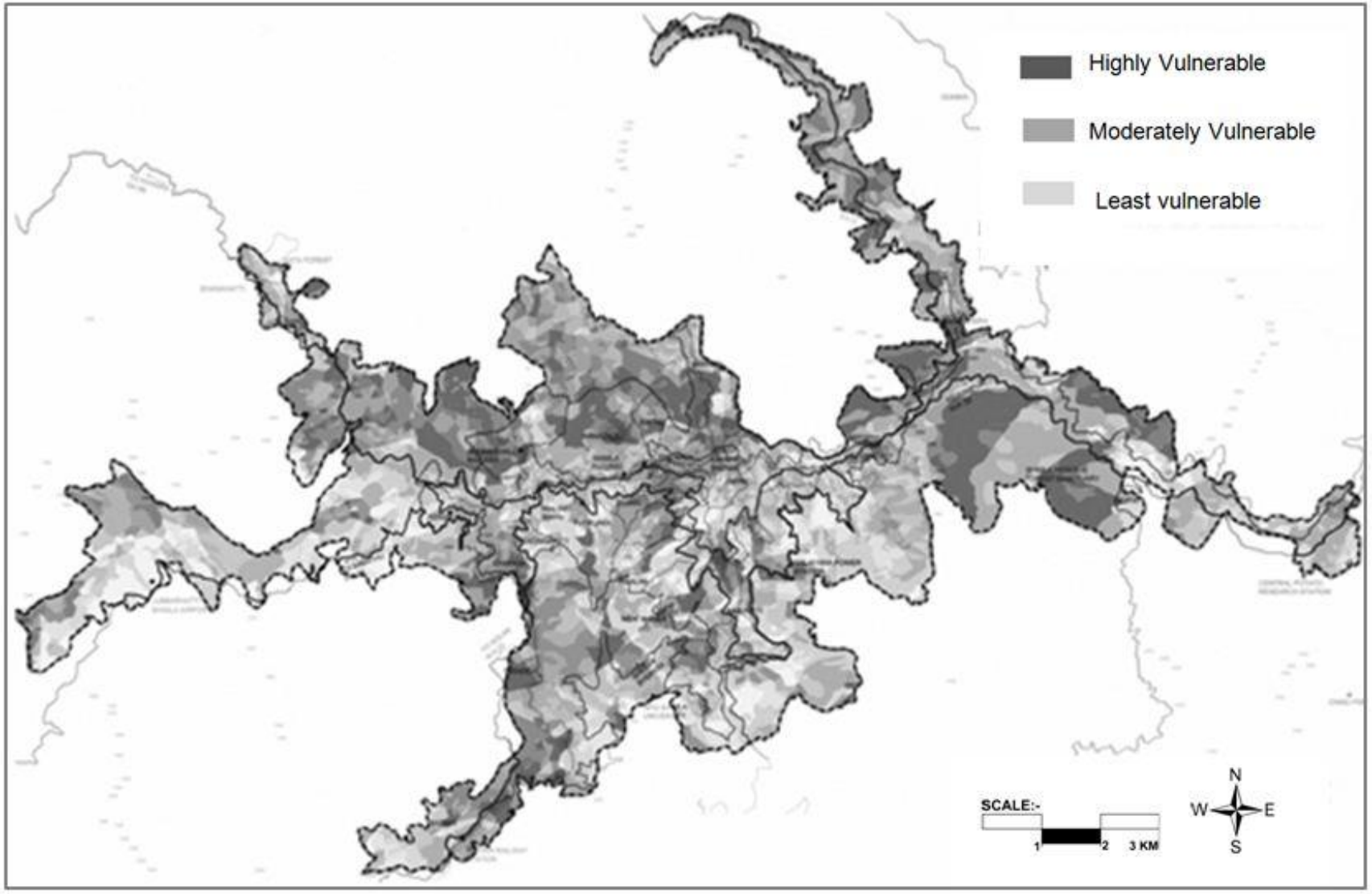
Land suitability map was superimposed on zonal level potential and constraint map, existing land use, solar zoning map to identify locations which were suitable for future growth and for harnessing solar energy.

Overlays led to only **35-40% land available from highly suitable parcels** and

25-30% land available from moderately suitable parcels for development,

Other limitations such as existing land use, 50m buffer along water streams, potentials and constraints were entwined to formulate spatial planning strategies for proposed land use 2021.

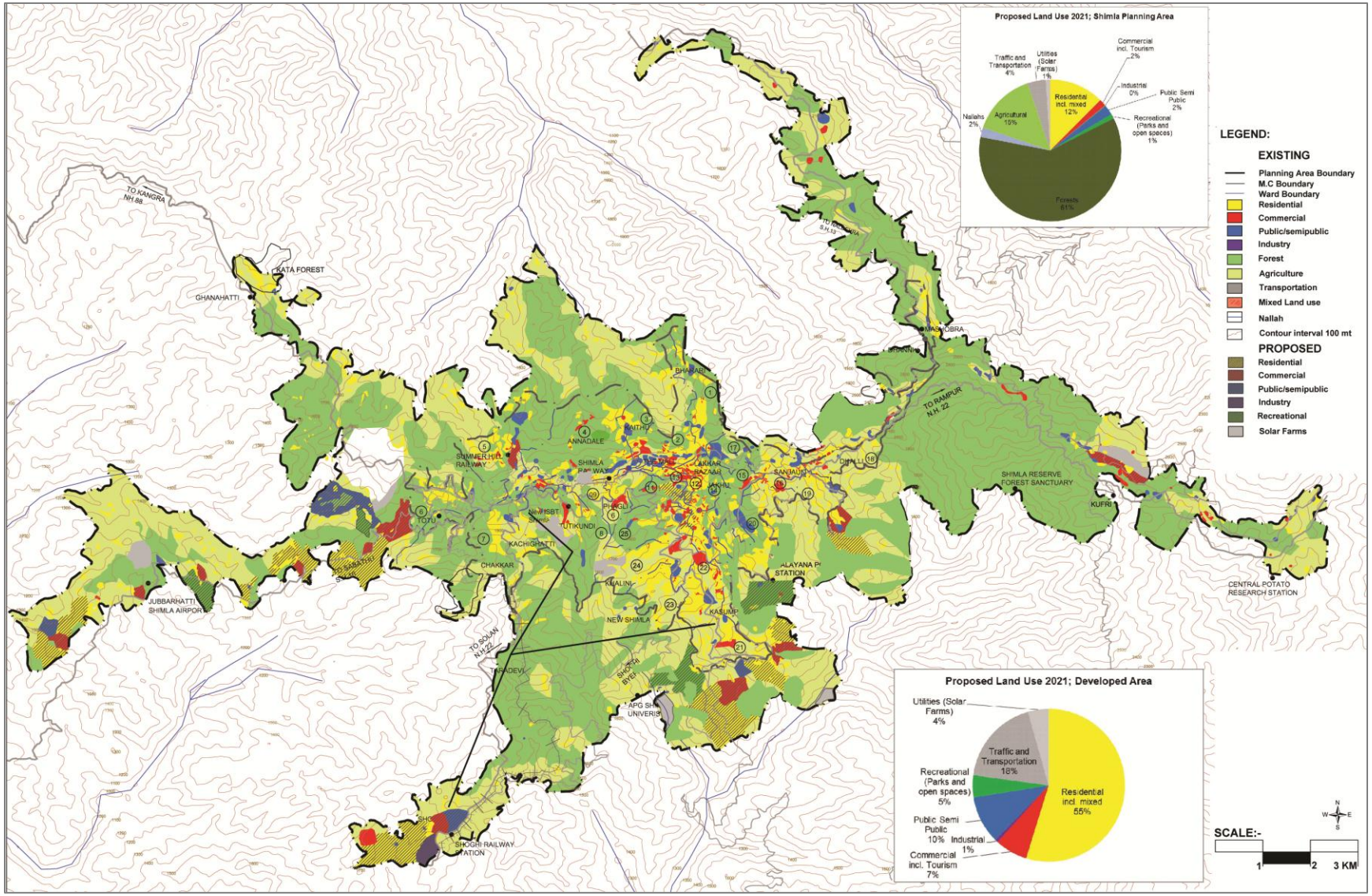
COMPREHENSIVE VULNERABILITY MAP FOR SHIMLA PLANNING AREA



Final Overlay; Comprehensive Vulnerability Map, Shimla Planning Area

Source: Prepared for the Study Fall 2014

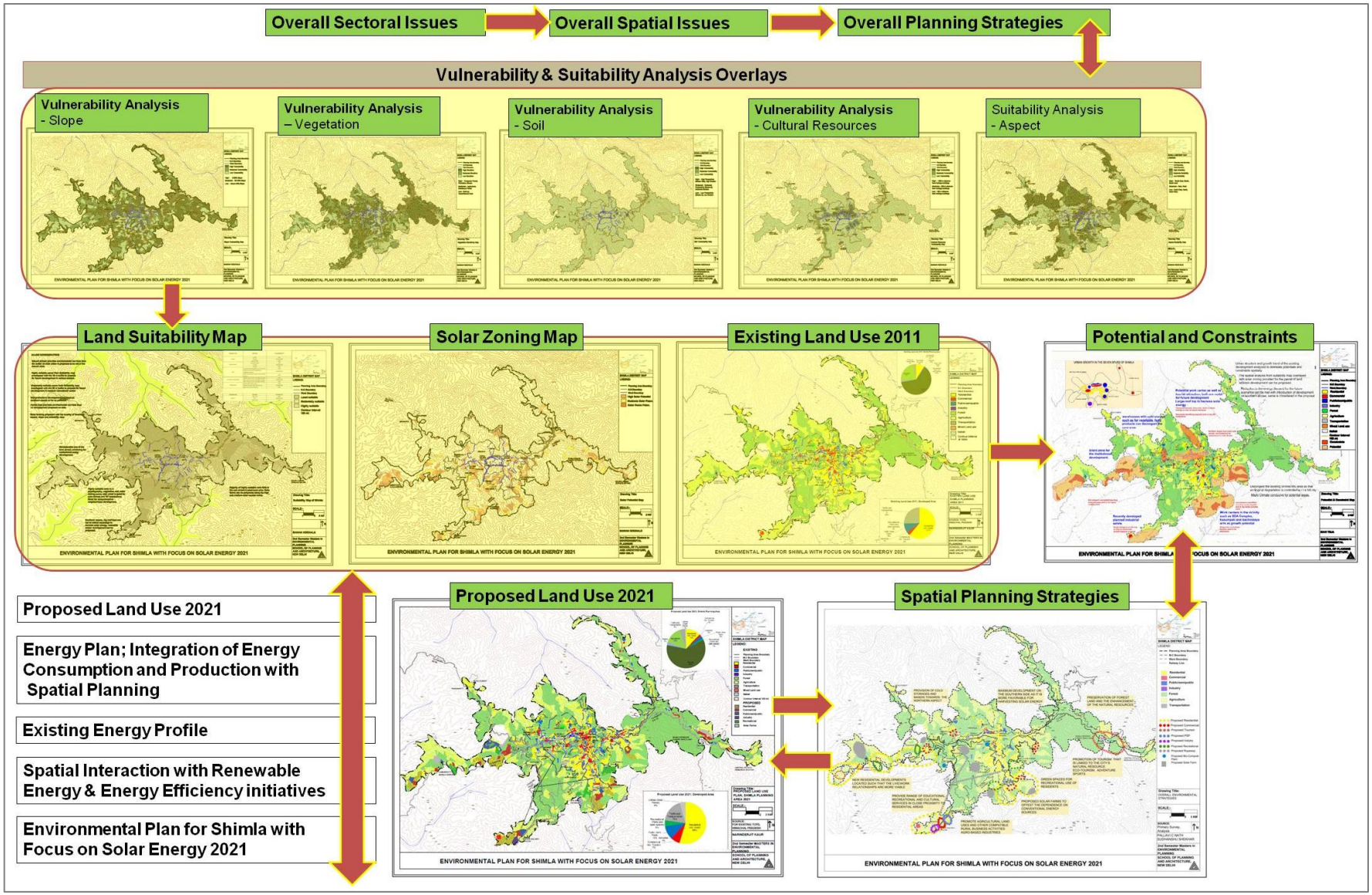
PROPOSED ENVIRONMENTAL PLAN FOR SHIMLA PLANNING AREA



Proposed Environmental Plan for Shimla Planning Area with focus on Solar Energy

Source: Prepared for the Study Fall 2014

CONCLUSIONS



Proposals; Process Summary

Source: Prepared for the Study Fall 2014

CONCLUSIONS

Degradation of city environments are connected to **'fuel for energy'**.

Renewable energy should be an integral part of any city **energy generating system**;.

India has **immense potential to harness solar energy.**

Initiative is required in form of **mainstreaming with present working structure** of regional plans/ master plans/ development plans.

Every sector planning needs should have **consumption and production matrix of RE and EE techniques**, not just demand and supply gaps.

Solar energy is **integral to renewable energy**.

Context is much broader and can be modified to be **part of the city planning mechanism**.

Shimla Planning Area study done in a hill city, had challenge in terms of working of solar zoning, much complex a case study with varying components, yet has **shown positive results**.

To **integrate energy demands, supply, consumption and production** on city level spatial planning to make our cities breathing with freshness and life.

Thank You

ABBREVATIONS

E East
EE Energy Efficiency
HIMURJA Himachal Pradesh Energy Development Agency
LED Light Emitting Diode
N, NE, NW; N North NE North East NW North West
RE Renewable Energy
SPV Solar Photo Voltaic
S, SE, SW; S South SE South East SW South West
PSP Public and Semi-Public
W West

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Renewable Energy Sources

Bioenergy; Renewable energy produced by living organisms.

Direct Solar Energy; Renewable energy produced by direct solar heat gain.

Geothermal Energy; Renewable energy produced by indirect solar heat gain. Harness thermal energy generated and stored in the Earth

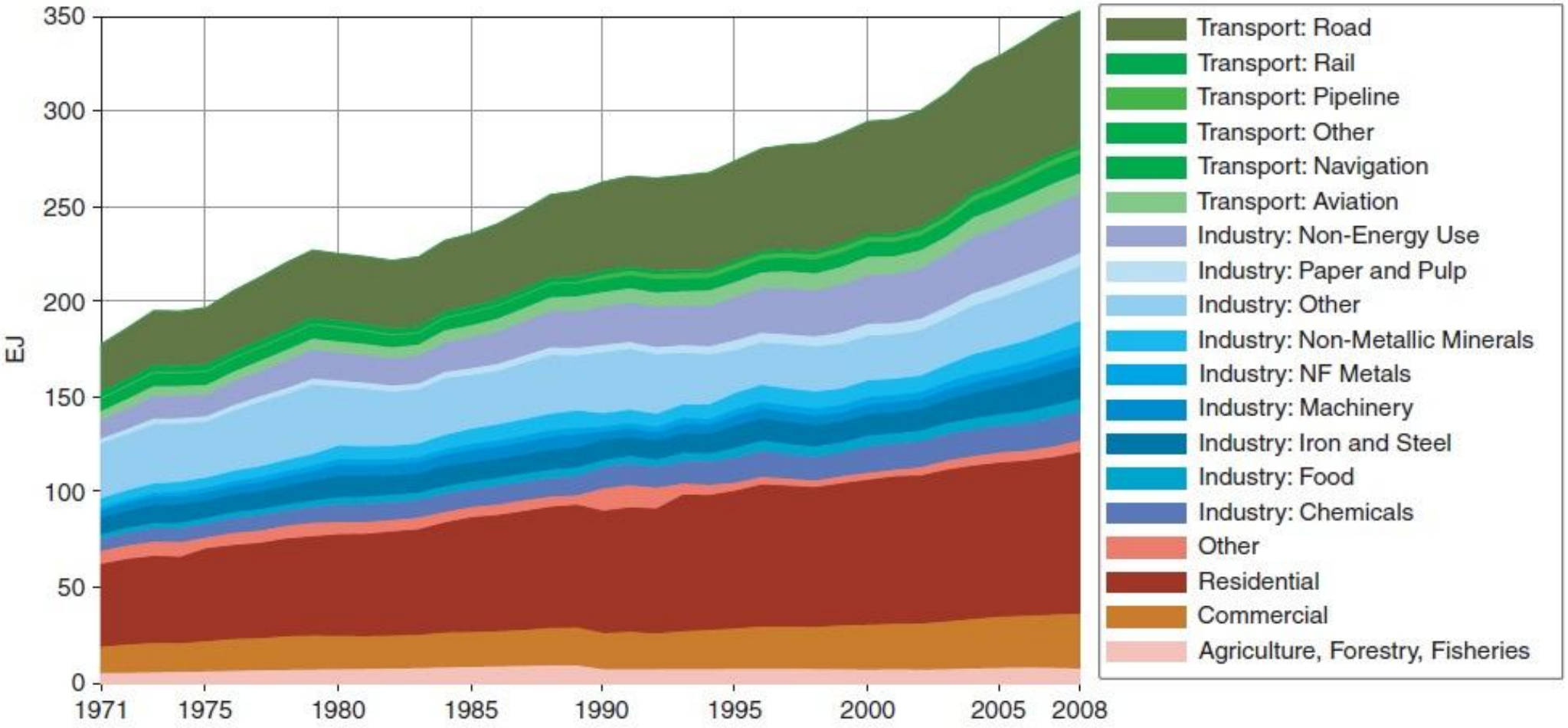
Hydropower; Renewable energy produced by water systems.

Ocean Energy; Harnesses the solar energy absorbed by the oceans to generate electric power.

Wind Energy; Electrical energy obtained from harnessing the wind with windmills or wind turbines.

Question to be pondered: Why RE Sources ?????

Energy Consumption



Global final energy input into different categories since 1971 (in EJ).

Source: Adapted from IEA, 2010