

Decision Theater for Planning

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- Why Decision Theater?
- Solar and wind power integration
- Transportation infrastructures



Question:
How much wind power can Karnataka add?
How fast?

Depends on

- Wind resource
 - Land availability
 - Economics
 - Road network
 - Transmission infrastructure
 - Managing intermittency
- We could write a report examining these
- Or

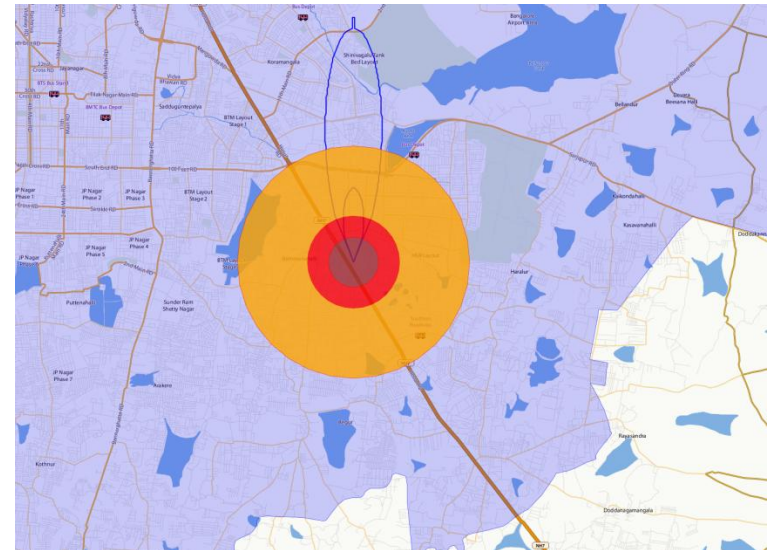
See it all together



Why Decision Theater?

- Public policy problems - complex
- Spatial & Temporal aspects
- Inter dependencies
- Stakeholder engagement

Nuclear incident



Chemical incident



City Master Plan



Why Decision Theater?

- High Speed computation:
 - Modeling complex systems
- Powerful and meaningful visualizations
 - Explore numerous scenarios
 - What If?
- Provide platform for experts to engage
- Engage stakeholders

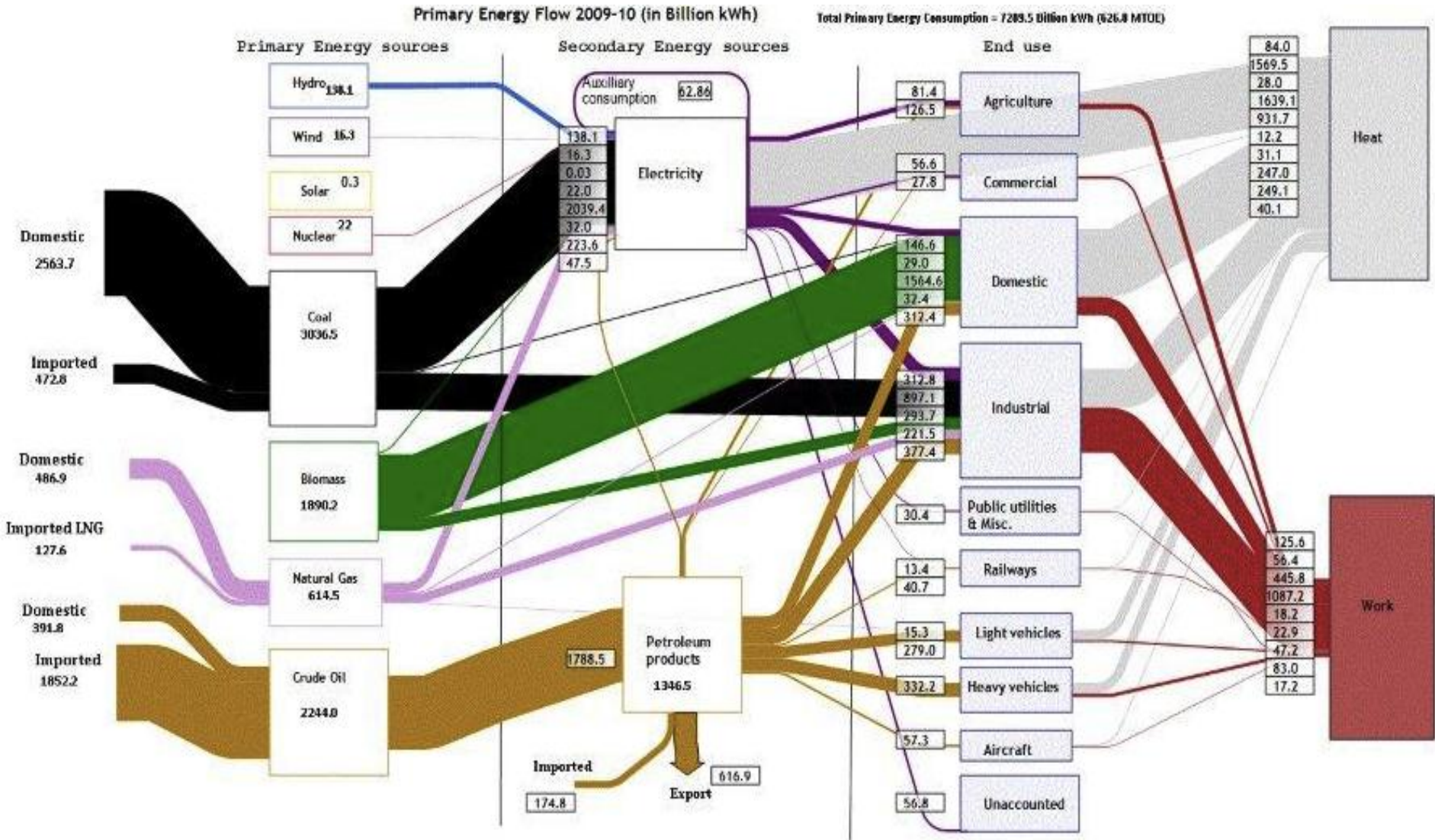
- Not for profit research institution
 - Energy, national security, materials, infrastructure
- Strong science, technology & policy focus
 - Expertise in computing, GIS, modeling
- Contributions to Planning Commission:
 - Low carbon inclusive growth
 - 12th Plan: “Scenarios shaping India’s Future”
 - 12th Plan: Chapter on climate change

India's Energy Scenarios

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India's Energy Flow Diagram (2009 – 10)



CSTEP, Bangalore

Power Sector (2012 – 20)

Sector	2012	2020 (Moderate)	2020 (Aggressive)
Coal Sub Critical	117,283	162,000	130,000
Coal Super Critical	0	35,000	40,000
Gas	18,903	25,000	25,000
Nuclear PHWR	4,460	7,260	7,260
Nuclear LWR	320	2,320	6,320
Nuclear FBR	0	500	500
Hydro	39,291	55,000	60,000
Wind	14,744	30,000	50,000
Biomass	2,768	4,000	4,000
Solar PV	958	6,000	10,000
Solar Thermal	0	2,000	5,000
Total	2,00,000	329,000	338,000

- Historically, wind potential : 49 GW
- Recent studies: > 500 GW
 - 80m
 - More land availability
- Revised official estimate: 103 GW
- CSTEP Study (Karnataka):
 - Wastelands > 45,000 MW
 - Agricultural lands (2%) 12.000 MW

How can we plan for large scale wind power?

Energy Decision Theater

List of Simulations:

S.No.	Simulation Name	Created On	Action
1	simulation_7	2012-10-17 06:19:41 UTC	View Delete
2	simulation_5	2012-10-15 05:44:45 UTC	View Delete
3	simulation_4	2012-10-15 05:43:52 UTC	View Delete
4	simulation_3	2012-10-14 10:36:46 UTC	View Delete

[Create New Simulation](#)

Energy Decision Theater

[Back to home](#)

Current Scenario (2012)

Total Demand (BU) = 60.6

Fuel	Capacity (MW)
Coal	3429
Gas	0
Diesel	234
Hydro	3669
CGS	1596
Wind	2130
Solar	14
TOTAL	11072

Input Screen for Scenario Analysis

Simulation Name

Select Year

Demand Growth (8-15%): **11%**

Projected demand for 2017 = **102.1** BU

Renewable Integration Scenario

Wind: **4000MW**

Solar: **1500MW**

Fuel	Planned Capacity (MW)	Expected Capacity (MW)
Coal	6600	<input type="text" value="4620"/>
Gas	700	<input type="text" value="489"/>
Diesel	0	<input type="text" value="0"/>
Hydro	775	<input type="text" value="775"/>
CGS	1437	<input type="text" value="718"/>
Total Conventional	9512	6602

Energy Generation (BU): **105.9**

Energy Shortfall (BU): **-4**

Energy Shortfall %: **-4**

Select Parcel

[Back to home](#)

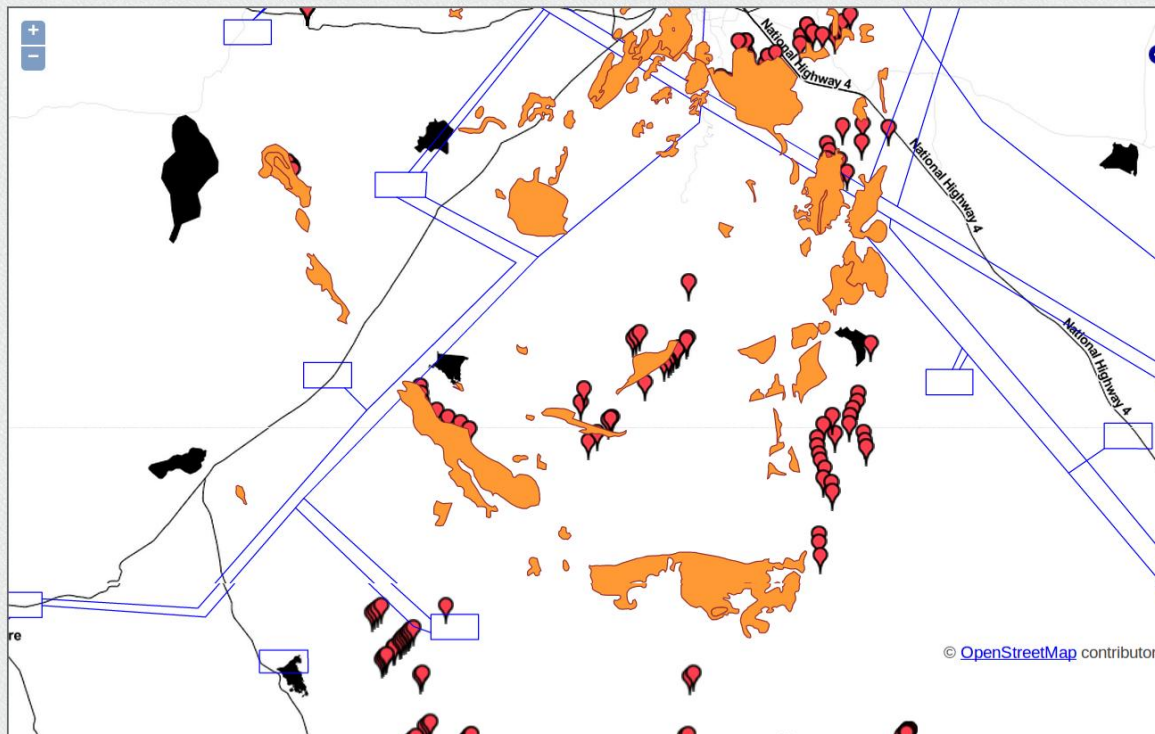
See WPD maps

80 m

100 m

120 m

	Waste lands suitable for wind power	Agricultural lands suitable for wind power
Area (sq. km)	7834	63799
Potential (MW)	54305	429193



Select Land and Height

Land Type

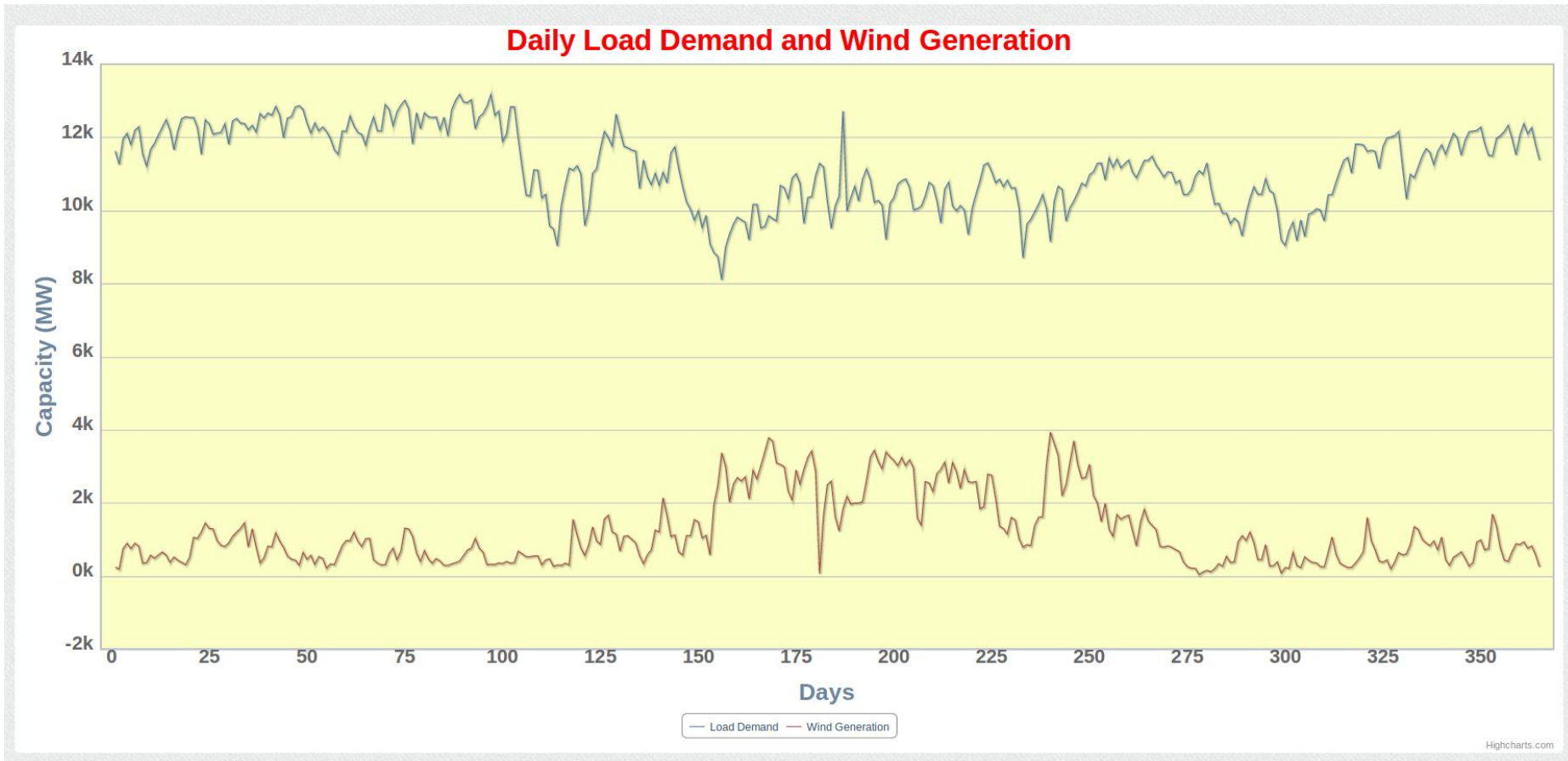
Hub Height(m)

Total Capacity
to be installed (MW): 4000

[Show on Map](#)

Parcel ID : 78
Area (sq. kms) : 2.540
Wind Power Density : 468.777069
Maximum Capacity (MW) : 20.316

DT-Energy: Screen 4



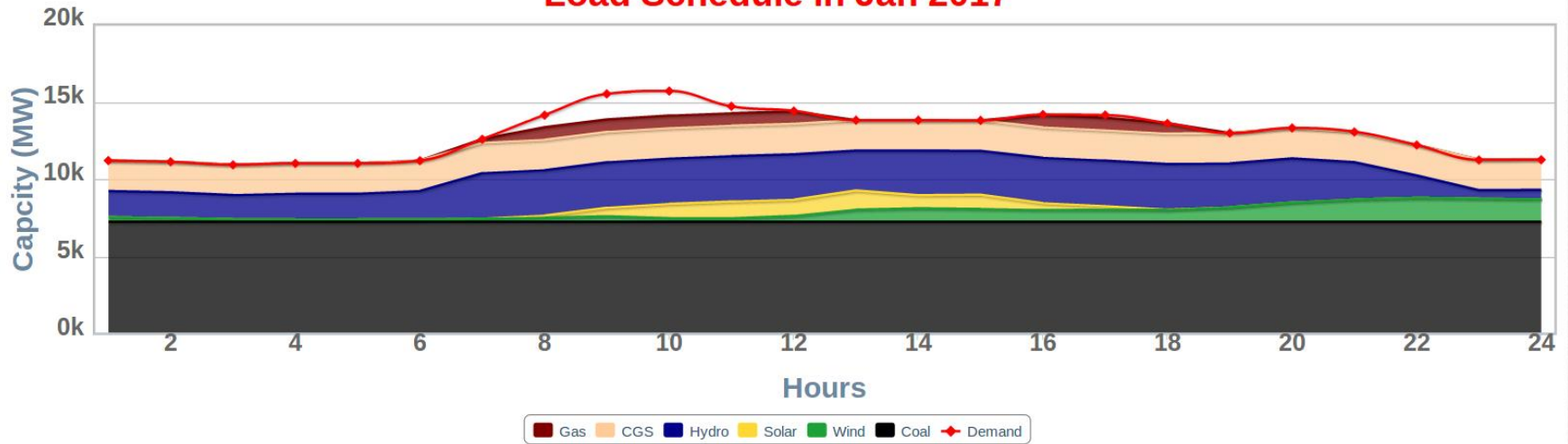
Minute wise Wind Generation On 11th August



Highcharts.com

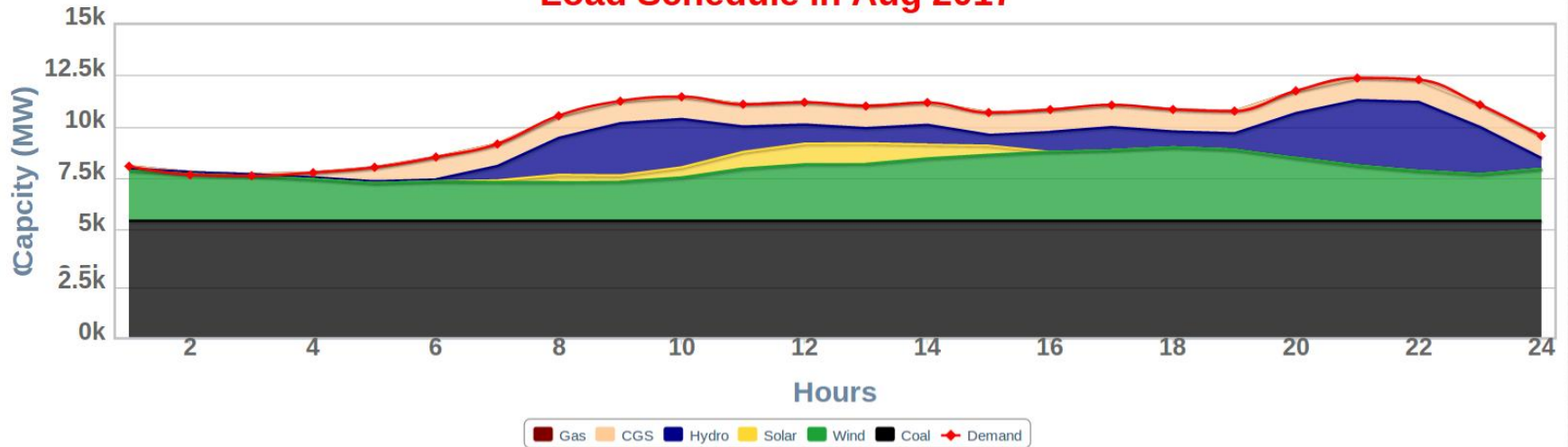
DT-Energy: Screen 6

Load Schedule in Jan 2017



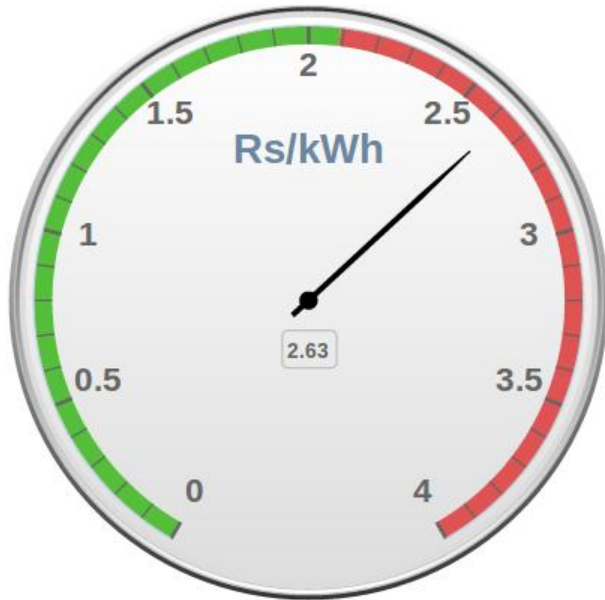
Highcharts.com

Load Schedule in Aug 2017



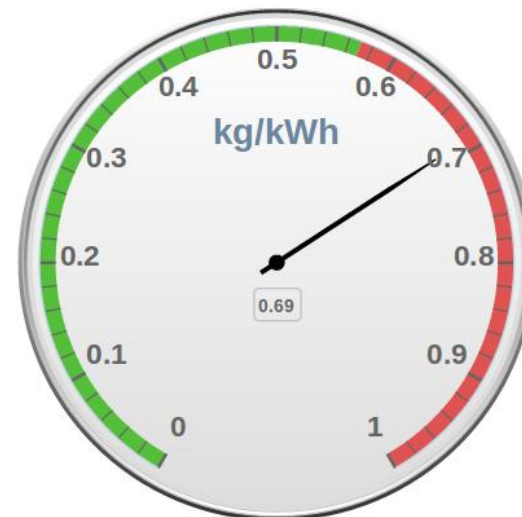
Highcharts.com

Cost of power



Cost: **2.63 Rs/kWh**

Emissions Factor



Emissions: **0.69 kg/kWh**

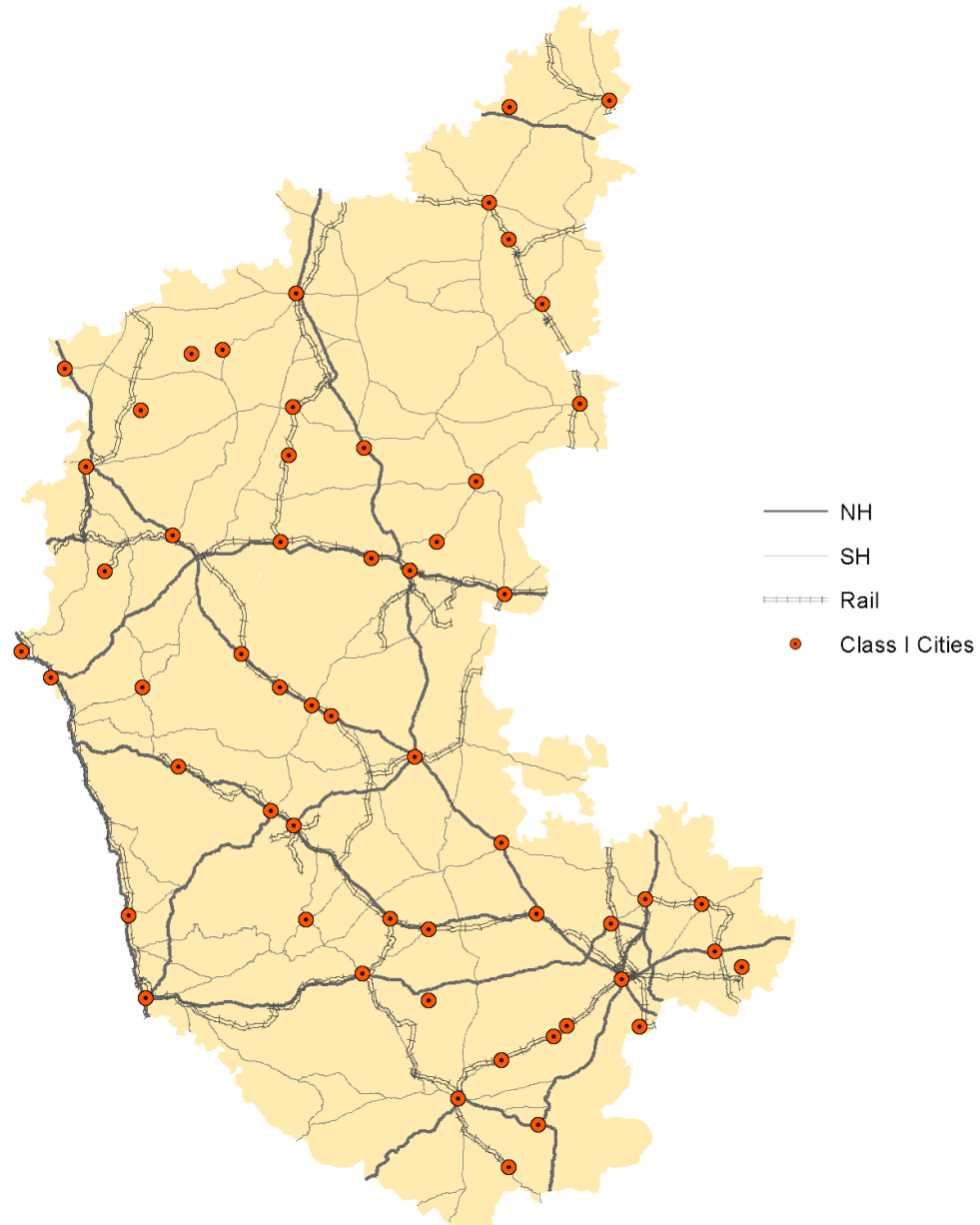
Highcharts.com

Decision making for up-gradation of transport infrastructure

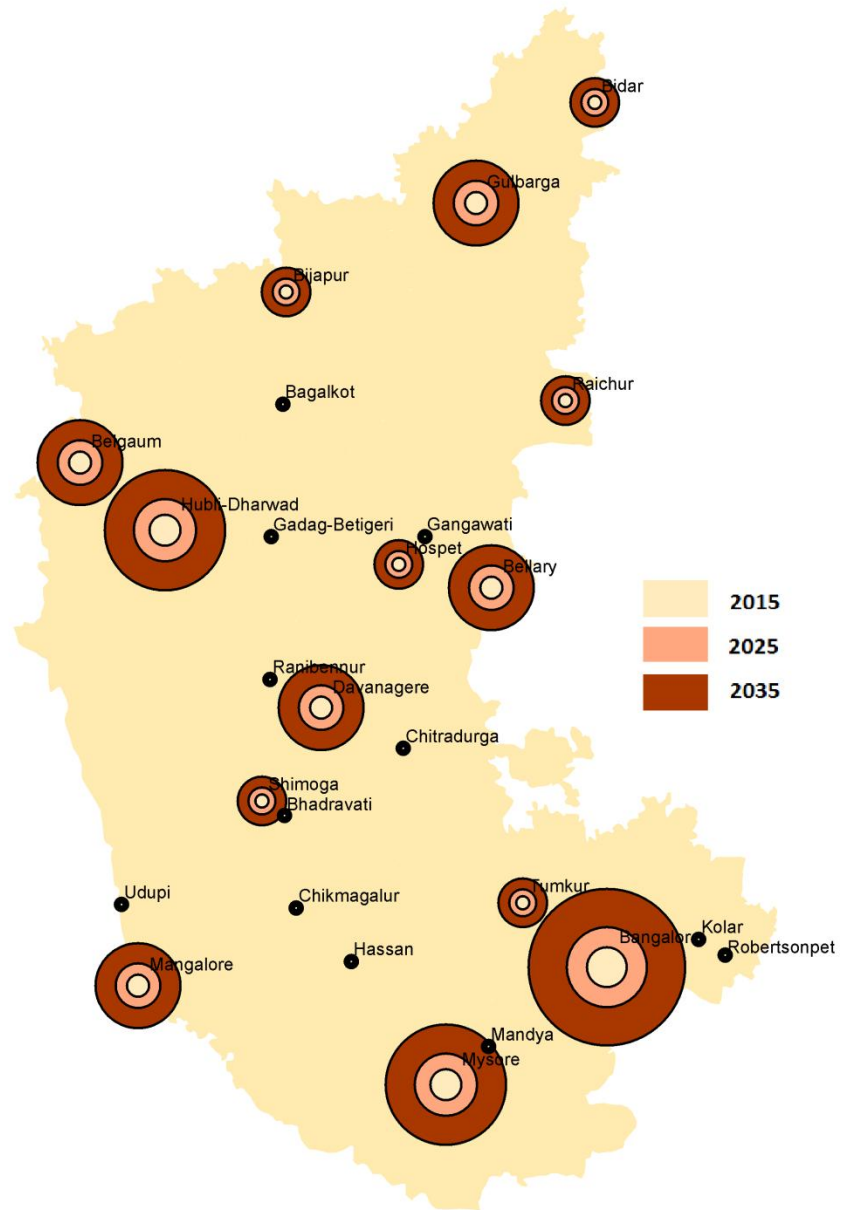
Focus on Karnataka

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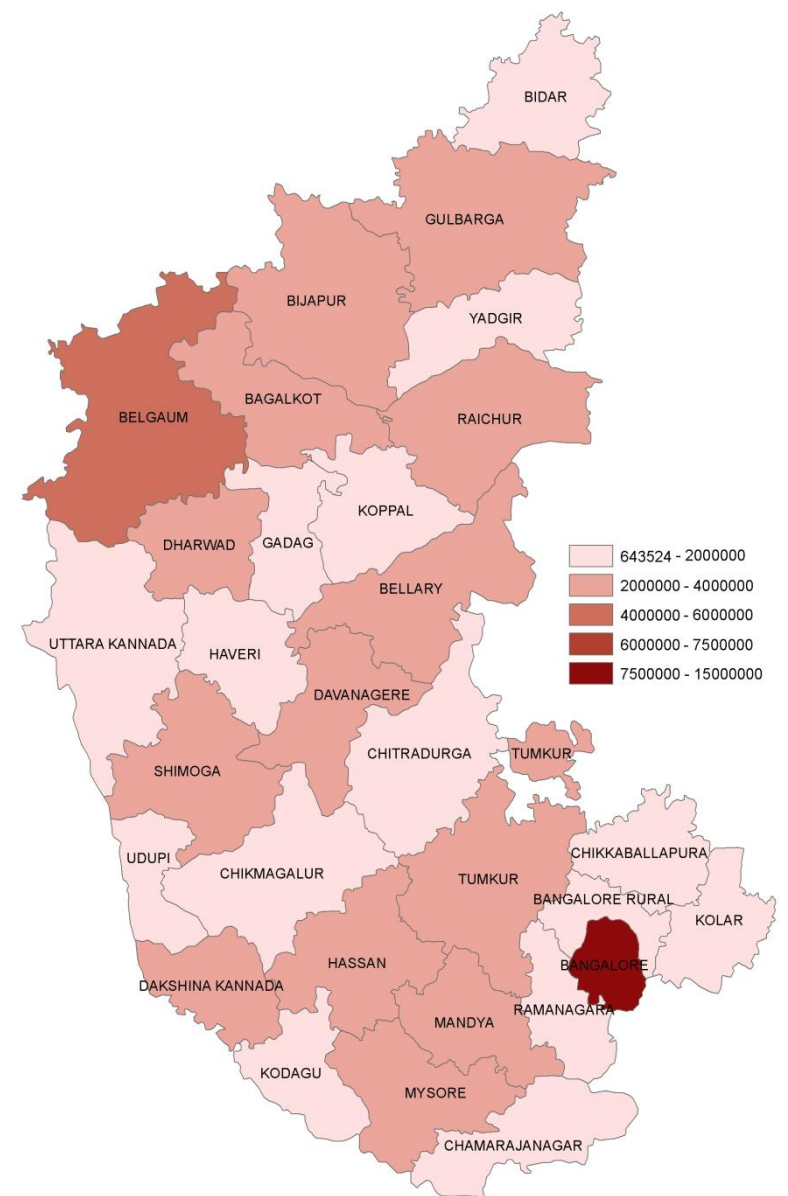
Transport Network (2005)



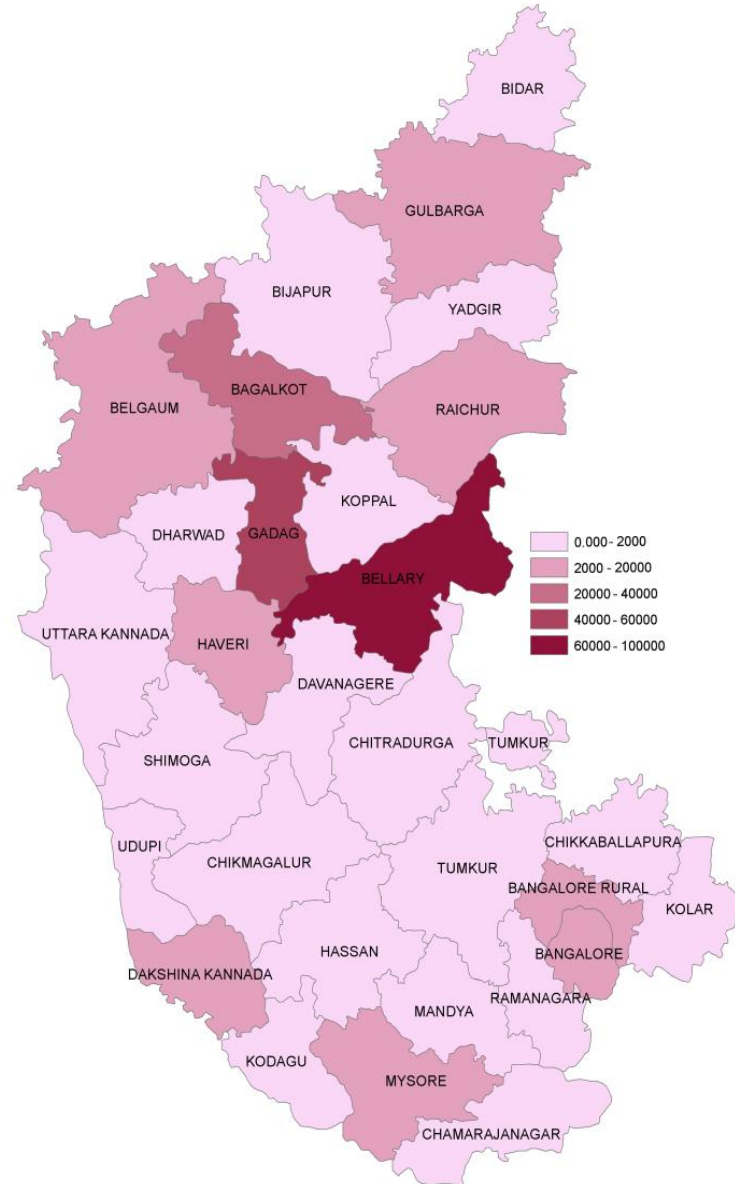
Cities Population Projection



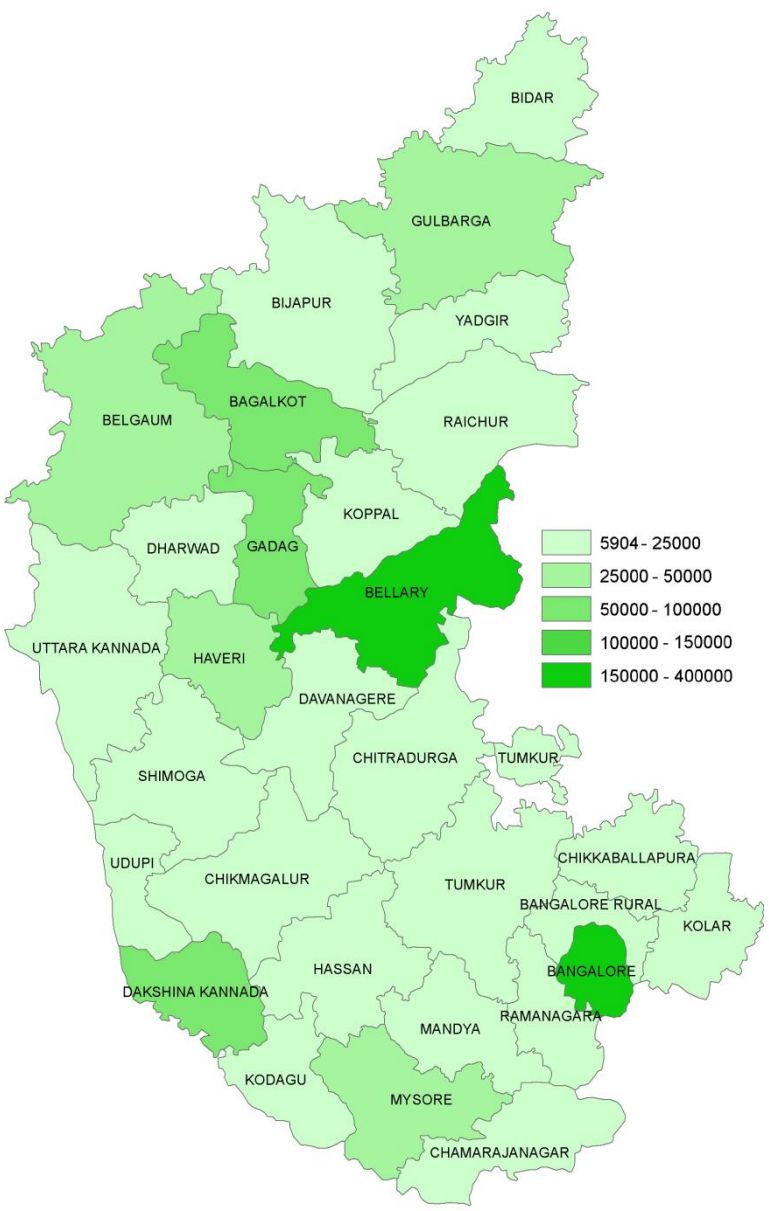
2025: Projected Population



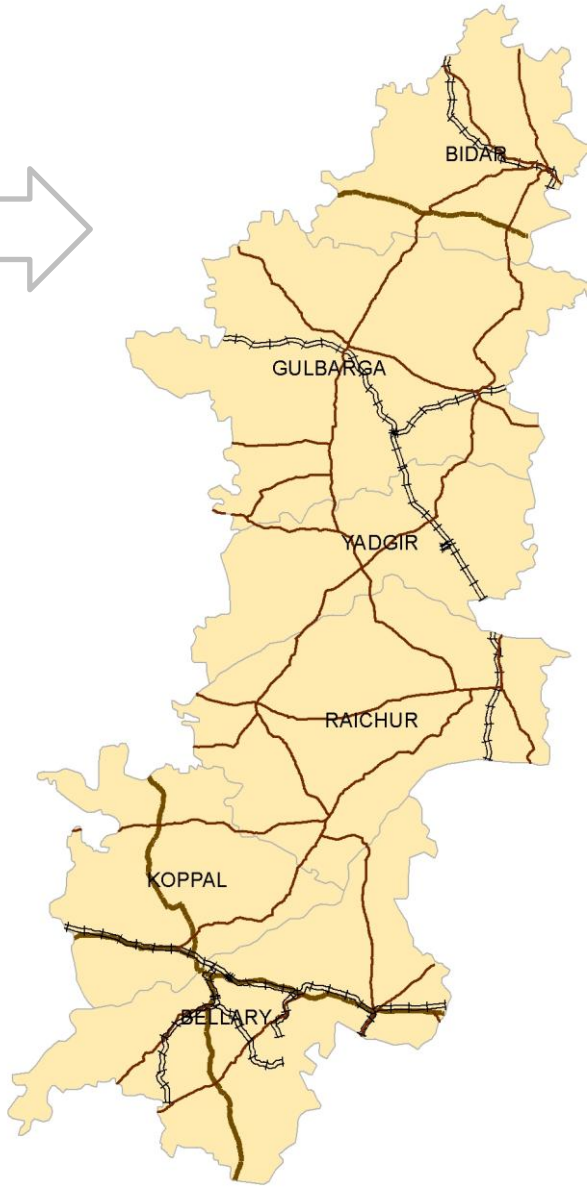
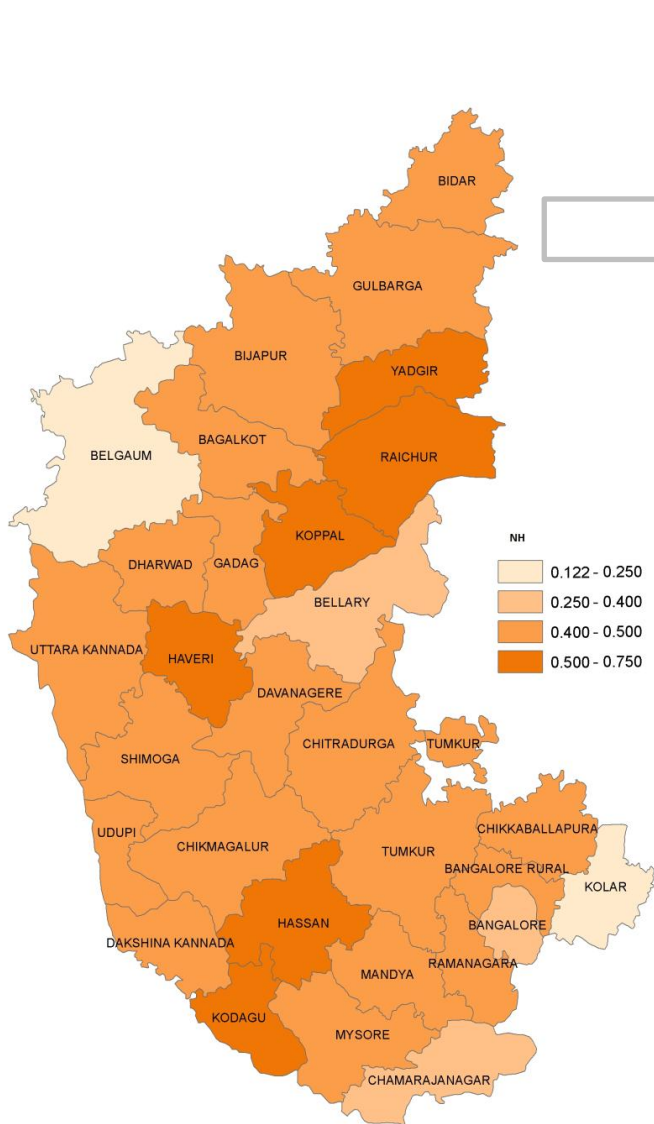
Proposed Investments (crores)



2025: Projected GDDP - Crores



Districts prioritized for transport improvement



District	NHRAIL
Kodagu	0.637179
Hassan	0.594786
Raichur	0.572824
Yadgir	0.563759
Koppal	0.550383
Haveri	0.522146
Dakshina	
Kannada	0.498834
Chitradurga	0.482929
Mysore	0.475775
Davengere	0.475619
Gulbarga	0.475291
Bijapur	0.47071
Bangalore	
Rural	0.469185
Chikmagalur	0.466269
Bidar	0.465889
Shimoga	0.463994

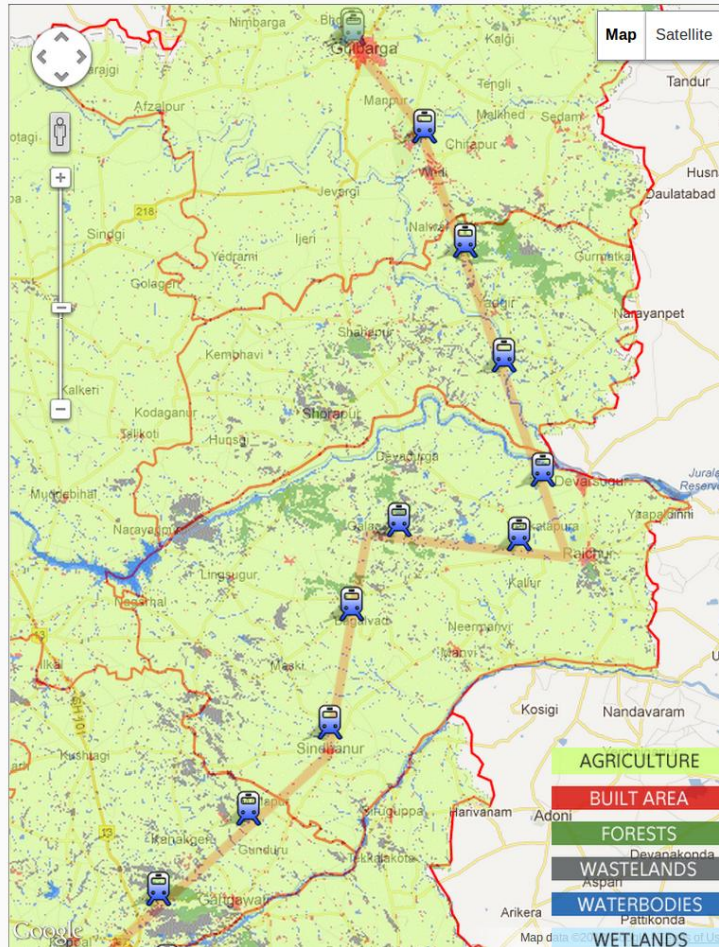
Transport Infrastructure Options



S.No.	Simulation Name	Transport Mode	Created On	Action
1	EXP_BEL_RAI_GUL_50	Express way	2012-10-15 11:34:04 UTC	View Edit Delete
2	HSR_BEL_RAI_GUL_50	HSR	2012-10-15 11:32:53 UTC	View Edit Delete
3	EXP_BEL_GUL_30	Express way	2012-10-15 11:31:34 UTC	View Edit Delete
4	HSR_BEL_GUL_30	HSR	2012-10-15 11:30:11 UTC	View Edit Delete

 [Create new Simulation](#)

Transport Infrastructure Options



Simulation Data:

Simulation name : `HSR_BEL_RAI_GUL`

Select mode:

HSR Express Way

Catchment Area Radius (in km)

16.0

Capacity (in %)

50.0

Land Usage Controls:

Show/Hide Land Use layer

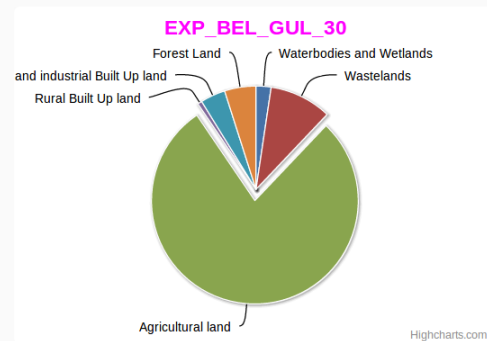
Edit Path

Transport Infrastructure Options

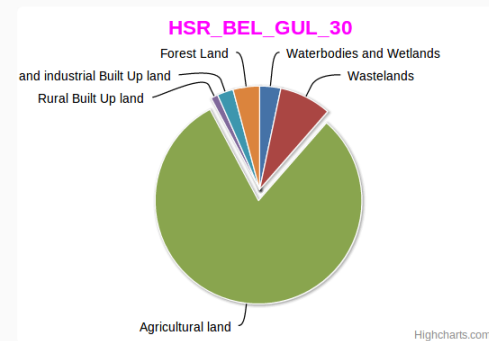


Compare Land Usage:

Scenario I: EXP_BEL_GUL_30



Scenario II: HSR_BEL_GUL_30



Land Type	Usage in hectares S - I	Usage in hectares S - II
Waterbodies and Wetlands	39.35	28.65
Wastelands	163.15	70.47
Agricultural land	1314.9	700.54
Rural Built Up land	11.57	9.59
Urban and industrial Built Up land	65.3	21.86
Forest Land	82.28	35.94

Transport Infrastructure Options



Compare Decision Parameters:

Scenario I: EXP_BEL_GUL_30

Scenario II: HSR_BEL_GUL_30

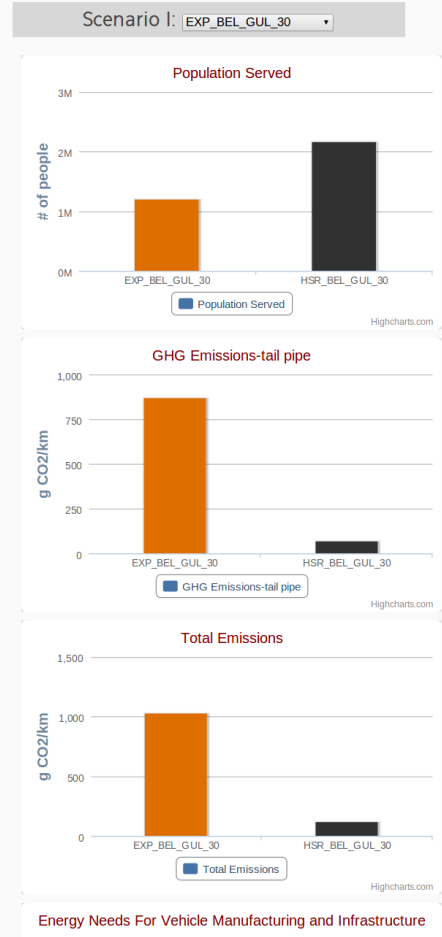
Parameter	EXP_BEL_GUL_30	HSR_BEL_GUL_30
Improve mobility		
Population Served (# of people)	1203220	2161800
Time Savings (over no build) (total passenger hrs)	58631.1	542629
Emissions		
GHG Emissions-tail pipe (g CO2/km)	870	66.957
Emissions-during vehicle manufacturing and operation (g CO2/km)	162.609	47.826
Total Emissions (g CO2/km)	1032.61	114.783
Emissions (g CO2 per passenger km)	21.844	1.201
Energy needs		
Energy Needs For Vehicle Manufacturing and Infrastructure (KJ/VKT)	343.75	1750
Energy Needs For Operating (KJ/VKT)	3000	562500
Total Energy Need (KJ/VKT)	25906.2	564250
Total Energy Need per Passenger (KJ/passenger km)	452.298	5906.22
Land Requirement and Cost		
Route Land Requirement (hectares)	5158.92	854.74
Passengers (per hr per hectare)	1.898	13.846
Land Cost (crores/hectare)	0.6	0.6
Total Land Cost (crores)	3095.35	512.844
Cost		
Economic Cost (Rs/passenger km)	144.925	0.34
Capital Cost (crores)	4467.13	86670

DT-Transport: Screen 5

Transport Infrastructure Options



Compare Decision Parameters:



Transport Infrastructure Options



Compare Decision Parameters:

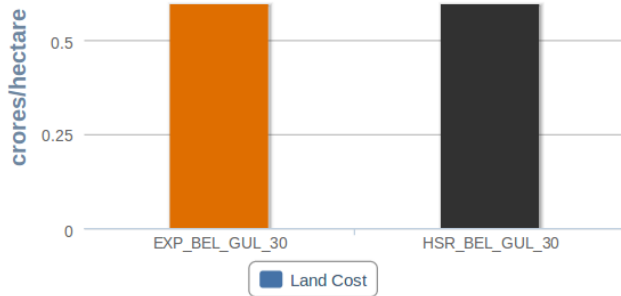


Transport Infrastructure Options



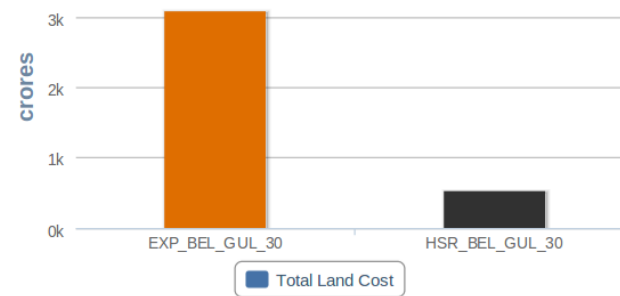
Compare Decision Parameters:

Scenario I:



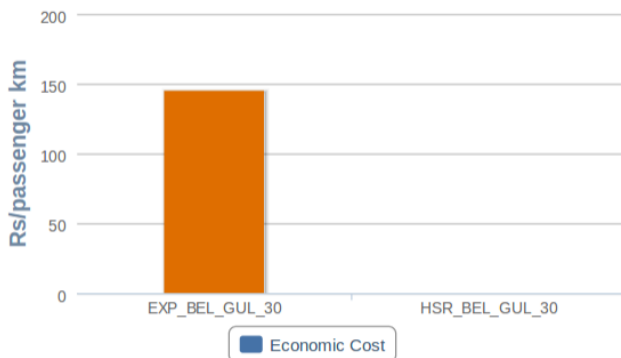
Highcharts.com

Scenario II:



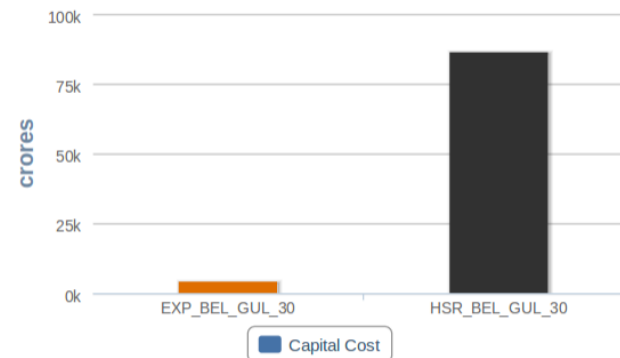
Highcharts.com

Economic Cost



Highcharts.com

Capital Cost



Highcharts.com

Thank You