SUDIGGAA

STUDY AND ANALYSIS OF OPTIMAL DISTRIBUTED GENERATION FOR ACCESS TO GRID ELECTRICITY FOR ALL IN FIVE YEARS WITH PARTICIPATION FROM LOCAL-LEVEL GOVERNMENT

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Outline

- Introduction and perspective
- Objective of the study
- Major components of the study
- Major findings of the Study
- Recommendations

Introduction and Vision

Electricity: Basic commodity & Essential input for industrial growth

Grid Electricity: Robust & Quality; Only 60% of the population have Access to Grid

SE4ALL & SDG7 Goals*: Universal Access to Electricity by 2030 (i.e. Tier-3 level of the MTF)*

In Aswin 6, 2074,National Planning Commission undertakes

- Study and Analysis of Optimal Distributed Generation for Access to Grid Electricity for All in Five Y with Participation from Local-level Government
- And the study identifies: "Sustainable Distributed Generation and Grid Access to All" (SUDIGGAA)

Two components – the two directions of the study

- Extension of Grid
- Distributed Generation

Introduction and Vision

Two components – the two directions of the study

Extension of Grid

Distrib
Genera

Extension of Grid

- for Access to Grid Electricity for All Municipalities; Capital intensive but can deliver high economic benefits
- Increases sustainability of Distributed Generation by providing access to grid for power balancing

Distributed Generation

- as a Bi-directional Solution for Grid Expansion and sustainability of remote distribution/ supply
- Provide the local means of income ; Comparatively reduce the demand on the central grid
- D.G. reduces Capex and Opex of T&D networks & provides reactive support to the grid and supplies local loads to reduce losses

Objective

Requirement study of all Municipalities

- for future load of 2023, and extrapolation up to 2027

Optimum Grid Expansion

- **Identify the optimum grid expansion** path with a substation optimally located at the Geo-demographic center

Optimal DG Selection

- **Find ONE small-scale renewable source of Generation** as Distributed Generation in each, that can be sustainable with network connection

Economic and Financial Viability Study

- **Economic and Financial analysis to select the optimum** generation option, and verify reasons for government investment.

Recommendation

- **Recommend a Workable Plan and Next Steps** for Sustainable Distributed Generation for Grid Access to All (**SUDIGGAA**)

Methodology

Step 1: Grid extension:

- Find population data of each municipality and project load for 2023 then to 2027
- Find existing electricity supply and electrification status data
- Find sites for Substations – Geodemographic center of municipality
- Find optimum paths of the grid expansion – modified algorithms – Kruskal and own improvised initiative

Step 2: For DG hydropower projects:

- Criteria is created to screen and find max. 3 best alternative sites
- In case of Hydro, Skirt the large projects (not to kill potential) , skirt DOED licensed projects
- Where Hydro is pre-emptively expensive, solar sites are located.
- Where solar sites are prohibitive due to prospective land costs (50 large/medium Town Municipalities), bio-mass sites are located
- Windpower is compared with other alternatives

Step 3: Financial Analysis and comparison for Selection of DG projects

- Financial analysis is performed to find the best alternative and determine the necessary investment and subsidy amount

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नेपाल विद्युत प्राधिकरण
Nepal Electricity Authority

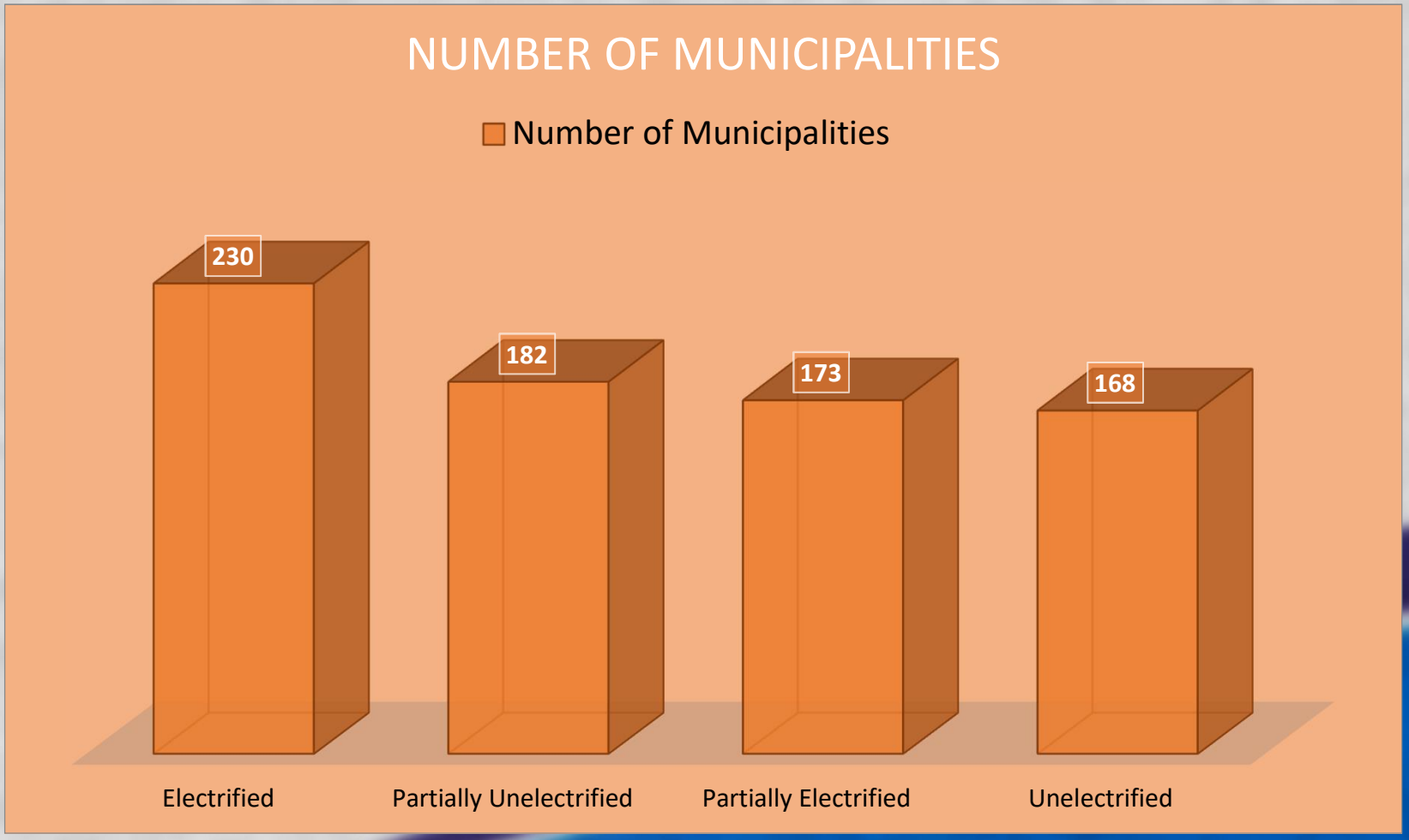
Government of Nepal
National Planning Commission
Central Bureau of Statistic

Domestic Load Forecast: Using CBS data of 2011

Load Demand Considered:300 kWh-Electrified; 180 kWh-Unelectrified in 202

Exisiting Grid Status: Through NEA & NEA DCSD.

Existing Electrification Status of Municipali



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Latitude, Longitude of GDC Calculated as,

$$X_{out} = \frac{\sum_{i=1}^{N} P_i X_i}{\sum_{i=1}^{N} P_i}$$

$$Y_{out} = \frac{\sum_{i=1}^{N} P_i Y_i}{\sum_{i=1}^{N} P_i}$$

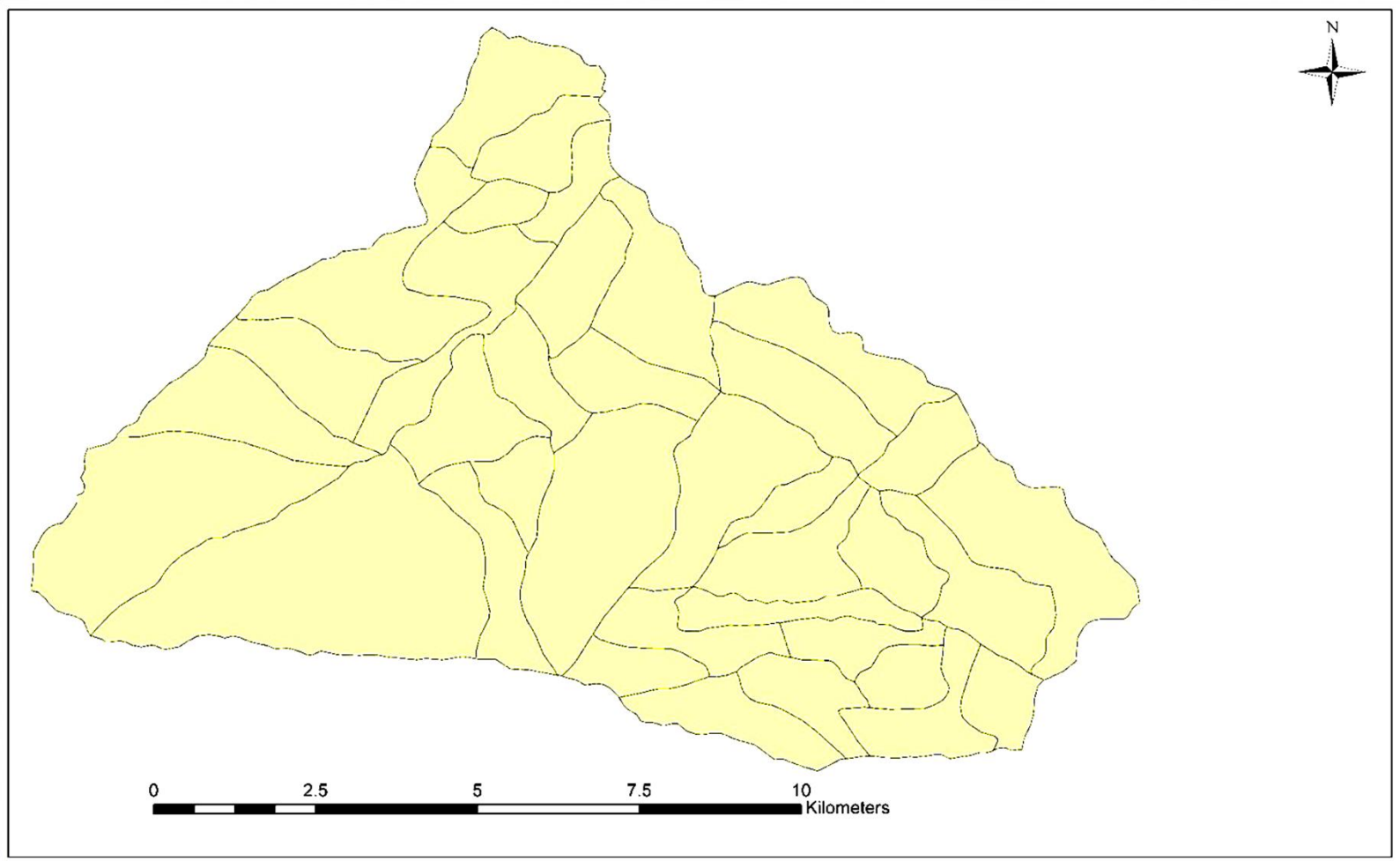
Where, N is the number, P is the population weightage, and X and Y are the latitude and longit of the wards within a County.

X_{out} and Y_{out} is the calculated latitude and longitude of the geo-demographic center

Methodology

Substation Site Finding: Geo Demographic Center

- **Example: Aathrai Tribeni, Taplejung**



Methodology

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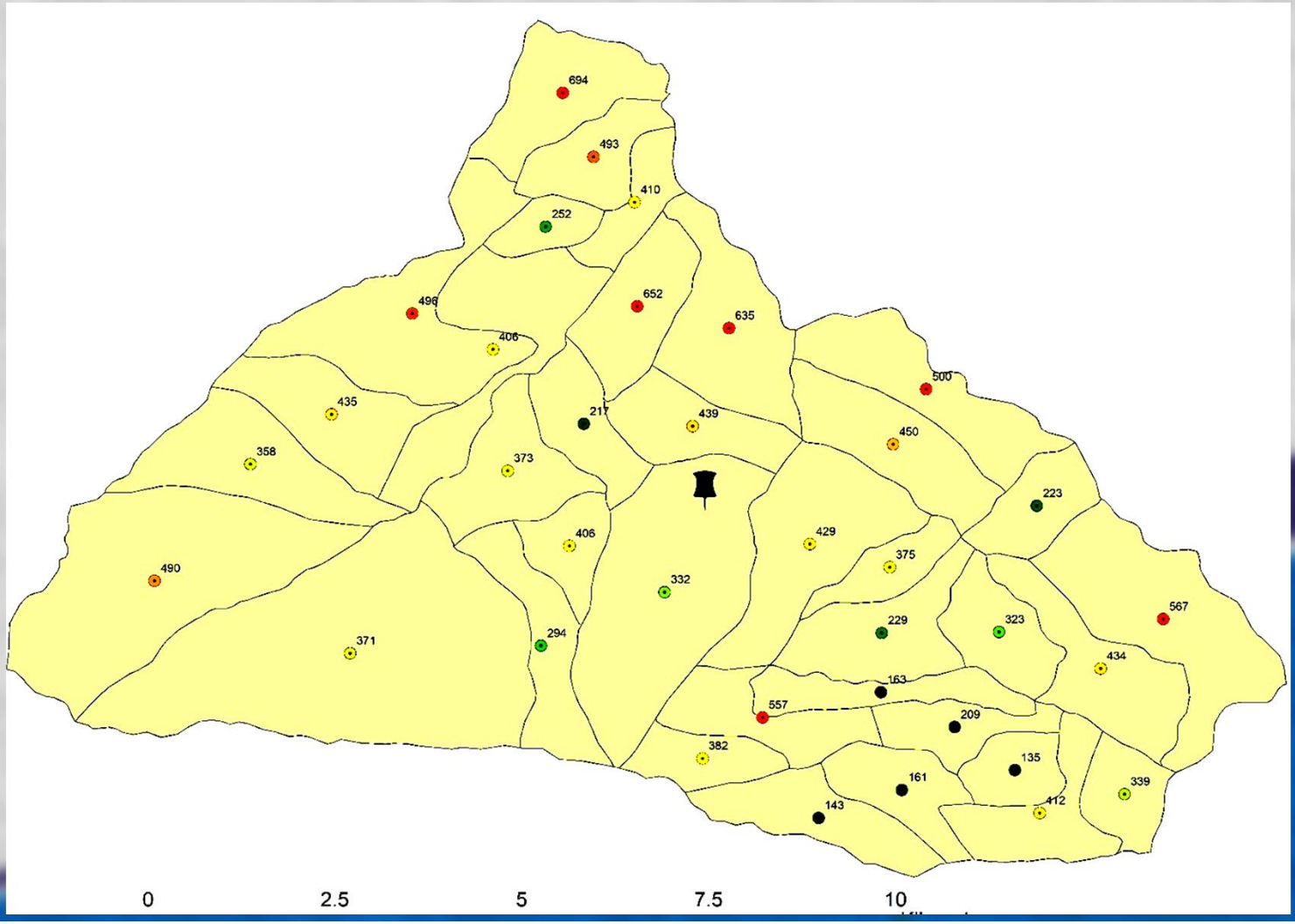

Methodology

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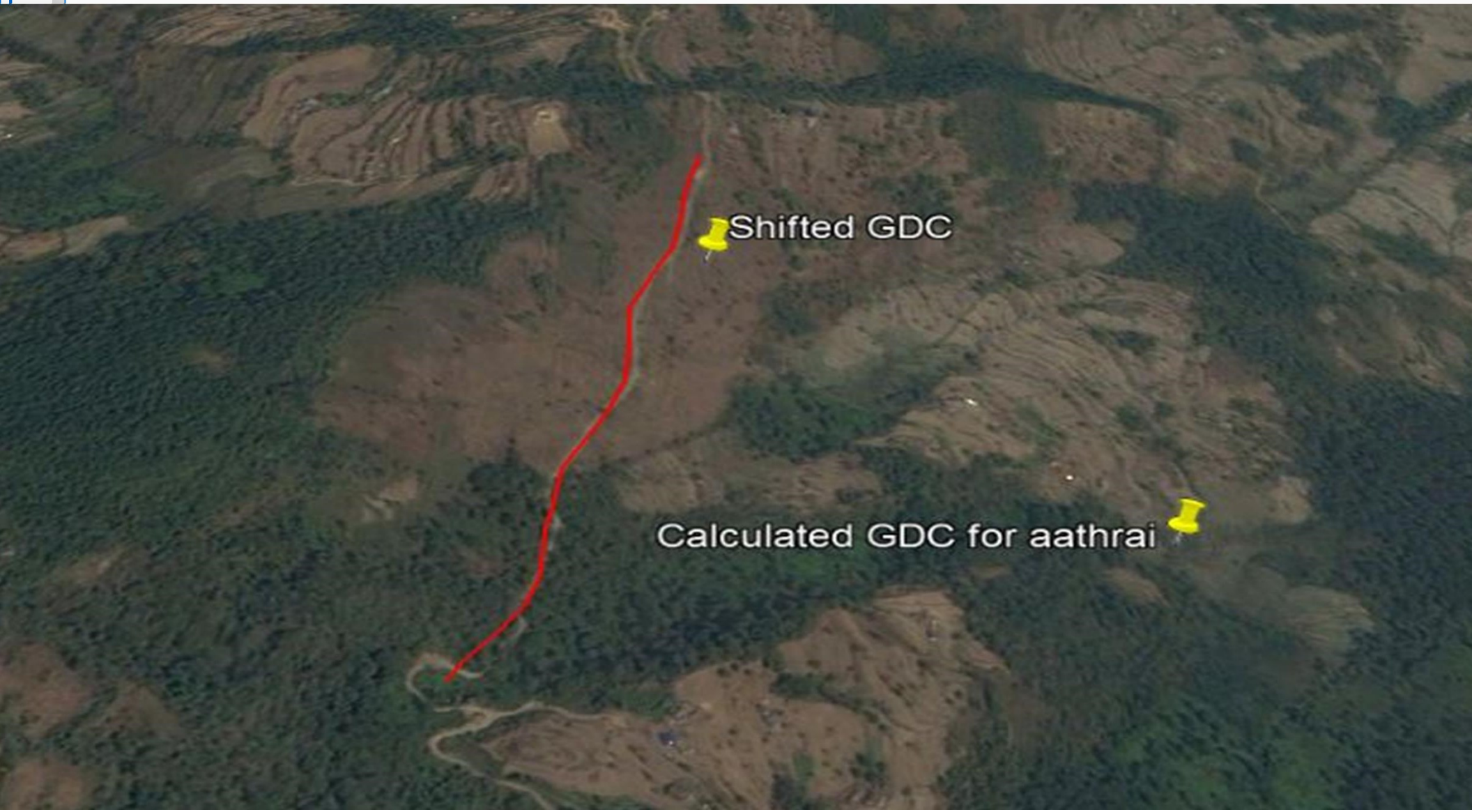
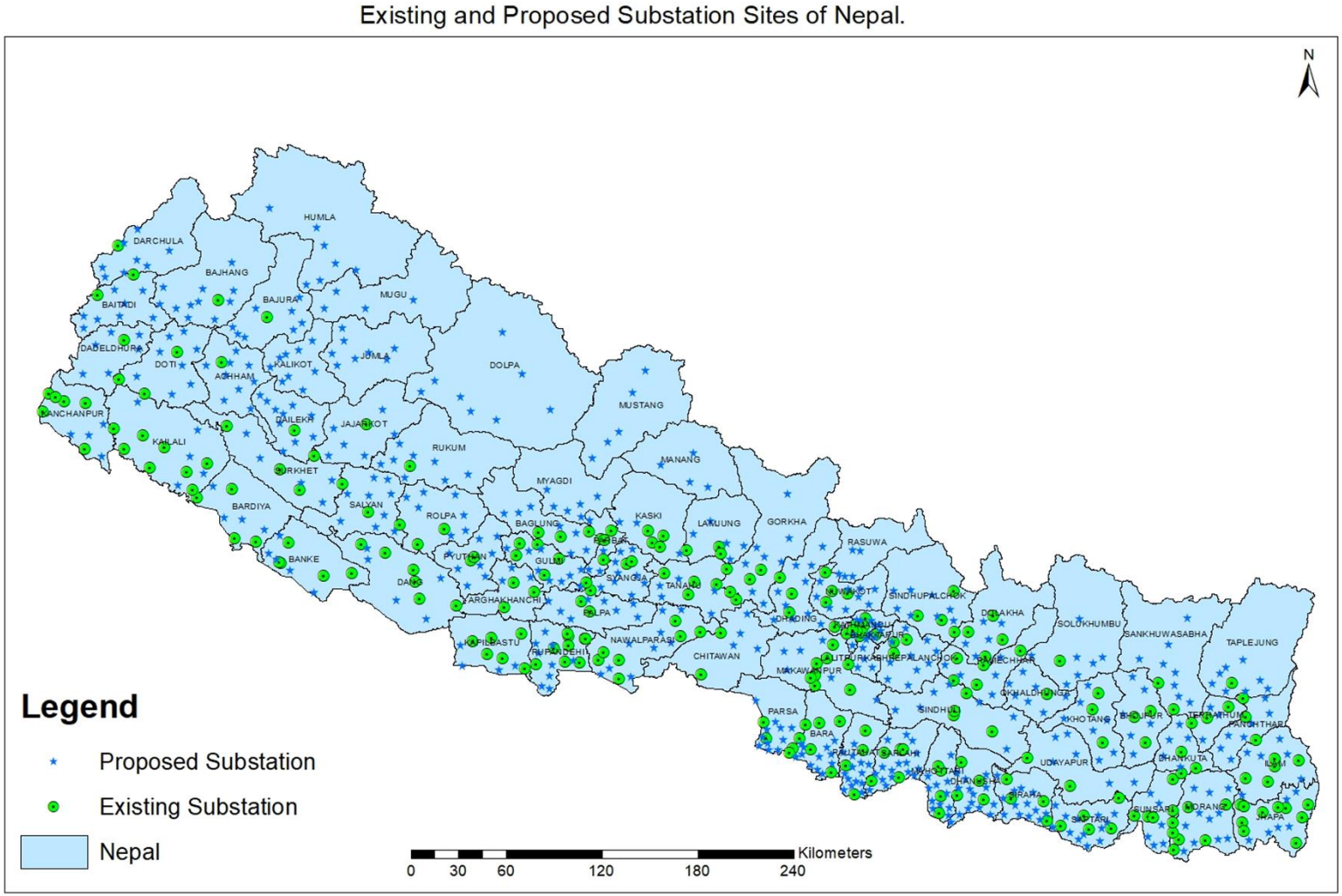


Methodology

Substation Site Finding



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- **Find optimum paths of the grid expansion – modified algorithms – Kruskal and own improvised initiative**

Create Two Pools each of existing and proposed substations.

Existing pool(EP): Existing or NEA Proposed ; Proposed pool(PP) : Proposed (GDC)

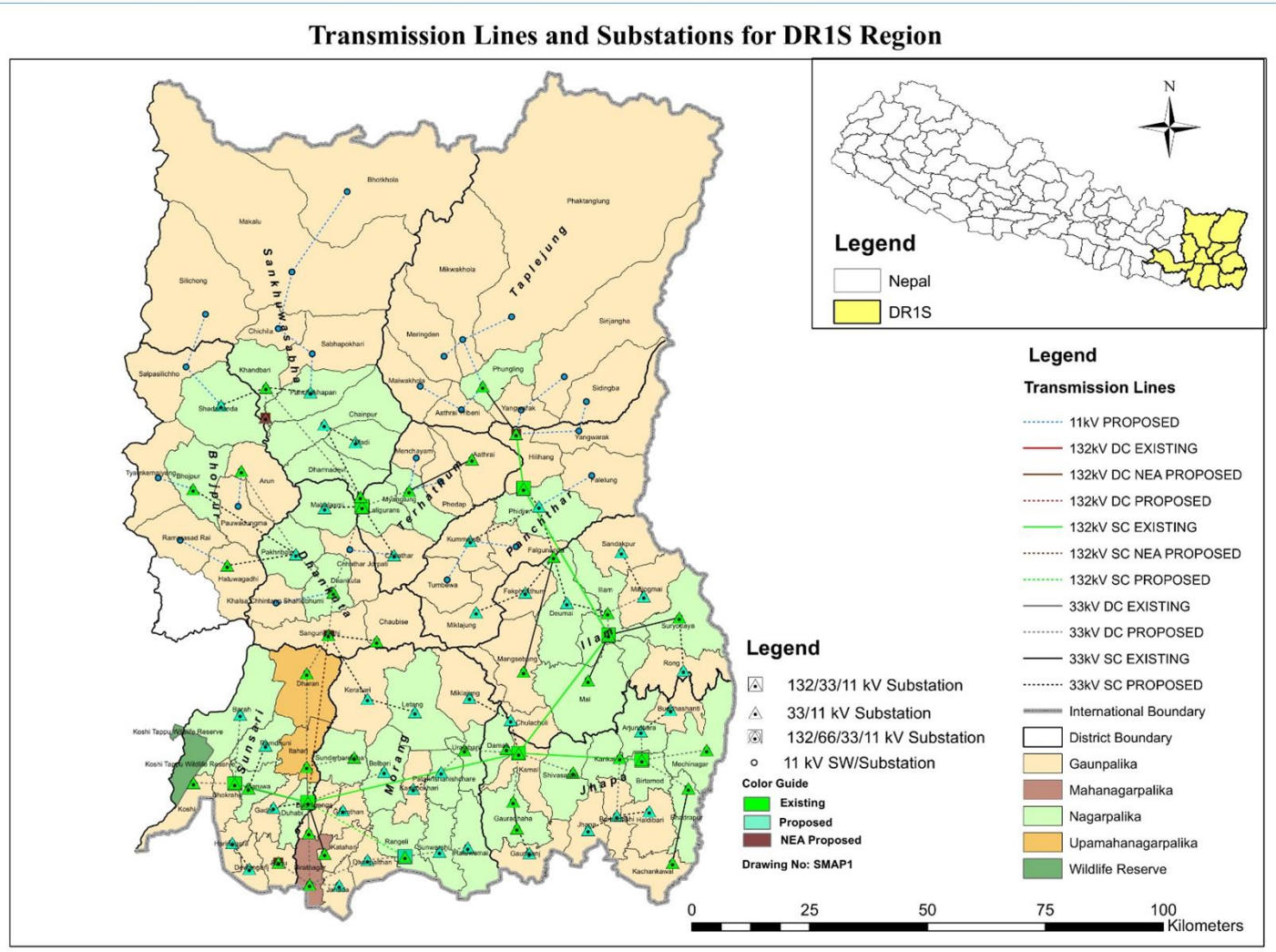
For each substation at PP, nearest substation at EP was selected based on minimum objectiv function which is a function of losses and voltage constraint.

Selected Proposed substation added to existing pool.

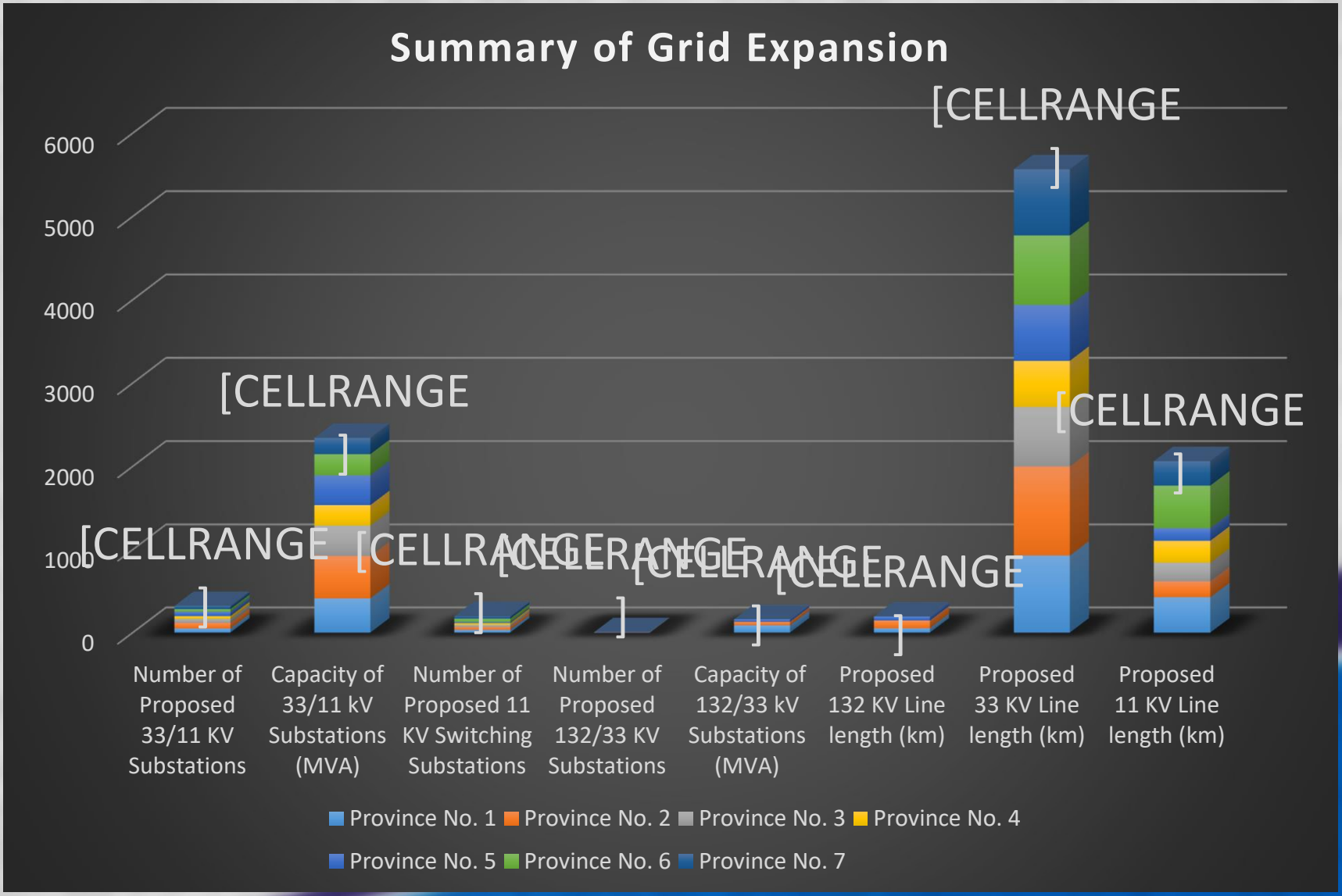
Methodology

Optimal Grid Extension

- **Algorithm: Kruskal and own improvised initiative**



Summary of Grid Expansion



Implementation Modality

Phase	Duration (yrs.)	No. of 132/33 kV Ss	No. of 33/11 Ss	No. of 11 kV sw.stn	Length of 132 kV line	Length of 33 kV line	Length of 11 kV line	Estimat Cost (N Million)
1	2.5	5	79	20	100	1540	270	14156.
2	1(+1.5 overlap	3	145	79	96.2	1895	843	22320.
3	1(+2.5 overlap)	0	99	100	0	2133.4	950.9	17326,
Total	4.5	8	323	199	196.2	5568.4	2063.9	53802

Methodology

Step 2: For DG hydropower projects:

- Criteria is created to screen and find max. 3 best alternative sites
- In case of Hydro, Skirt the large projects (not to kill potential) , skirt DOED licensed projects
- Where Hydro is pre-emptively expensive, solar sites are located.
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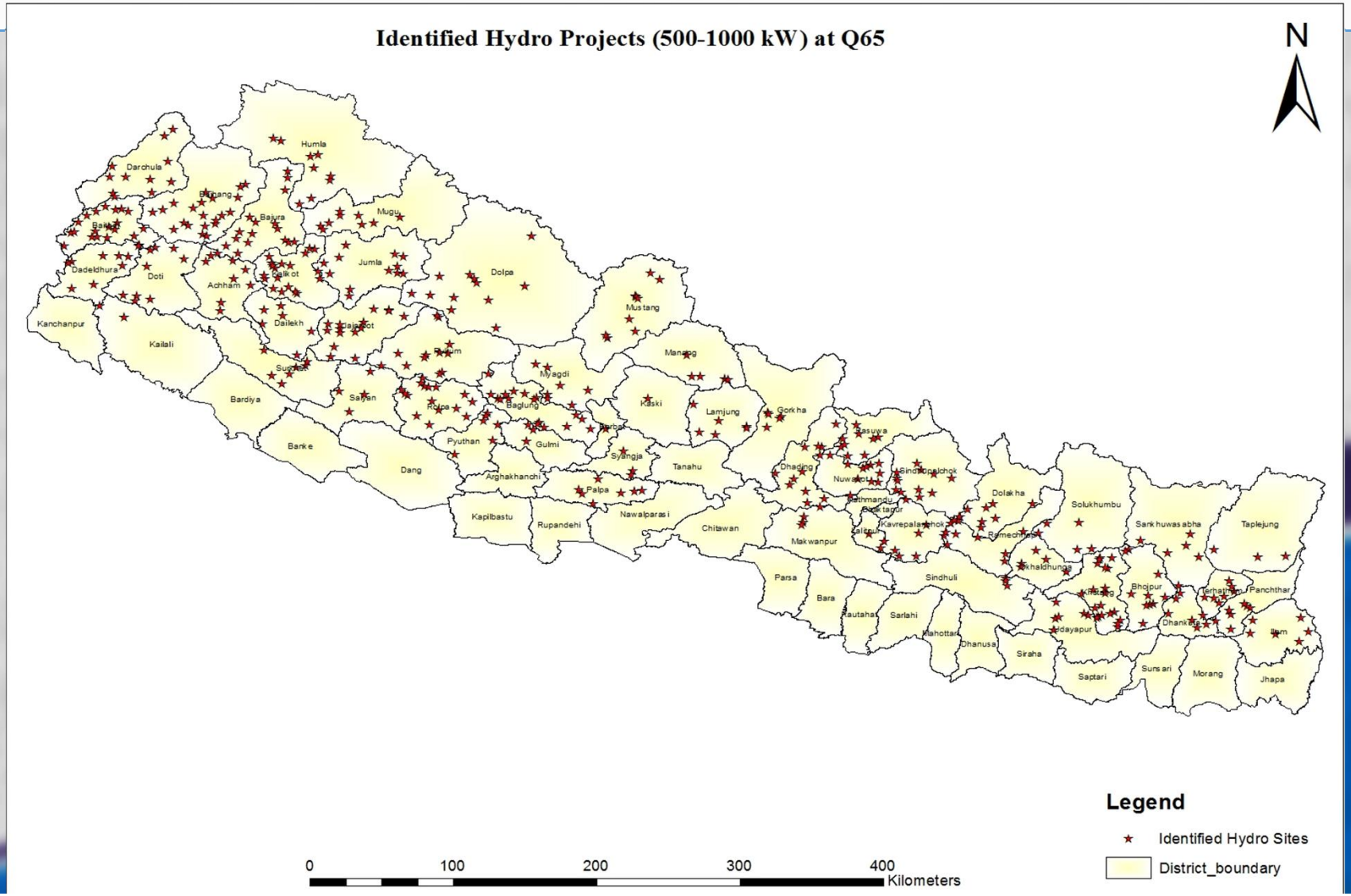
- Windpower is compared with other alternatives

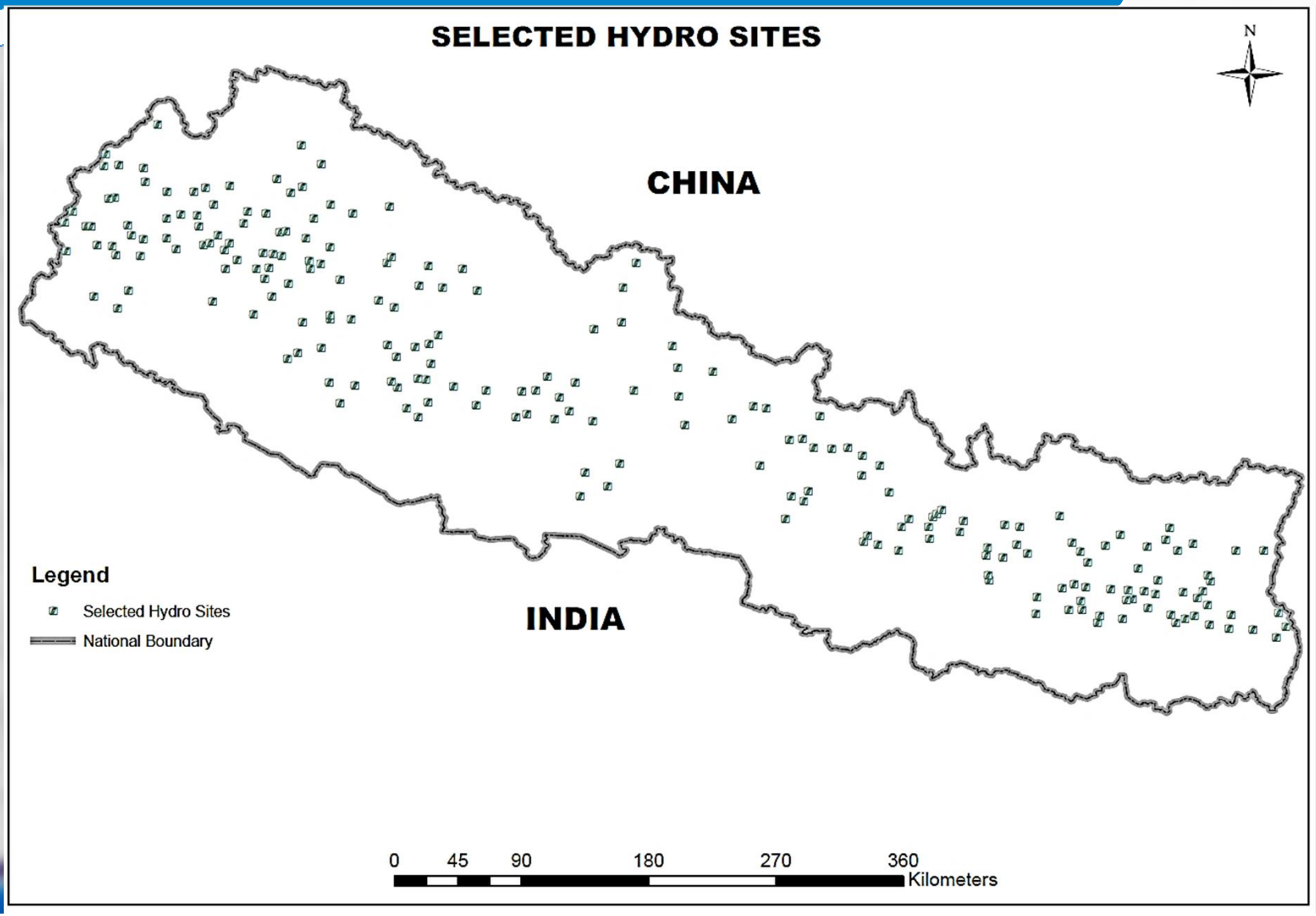
Methodology

Identified DG hydropower projects:



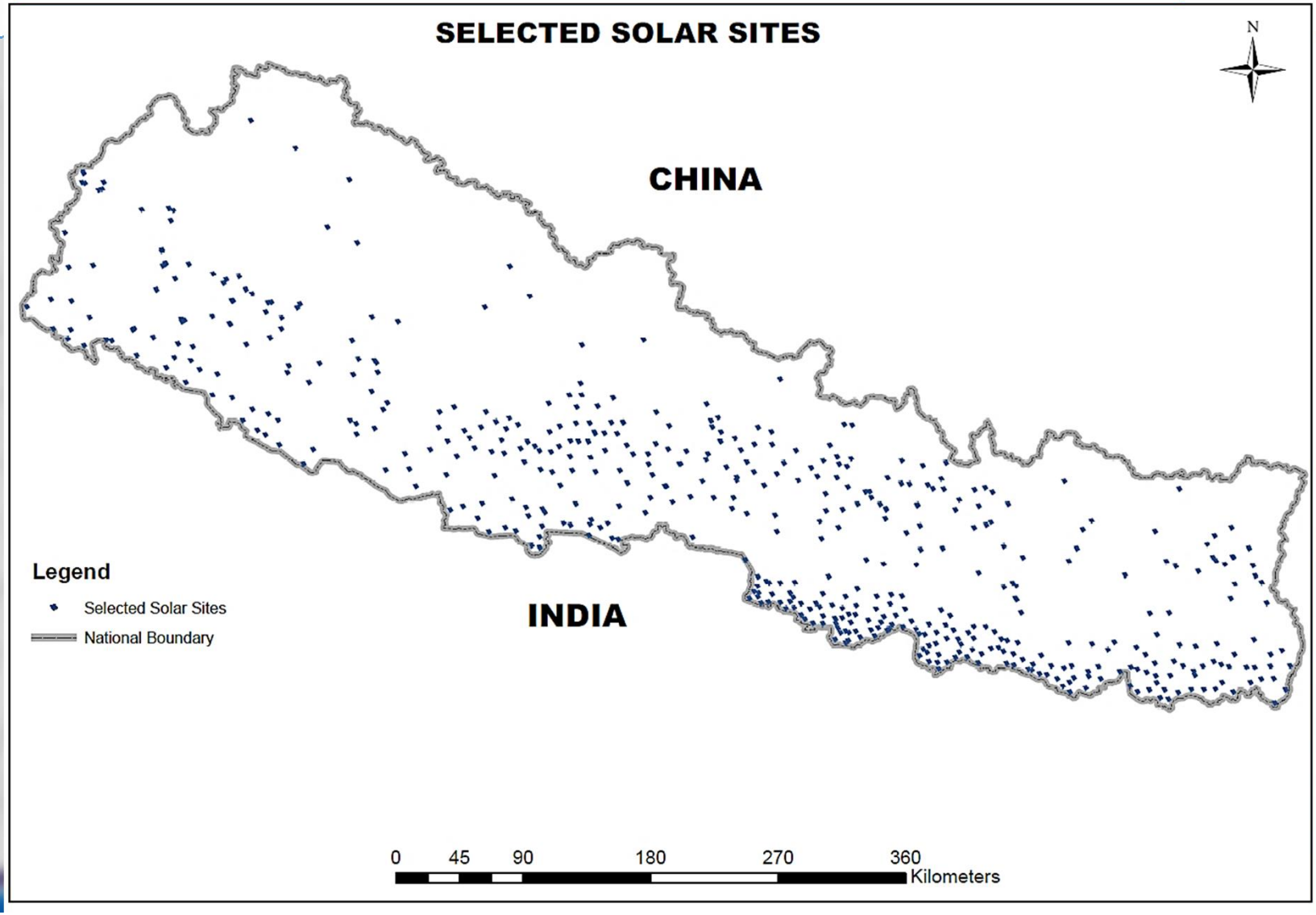
Methodology

Selected DG hydropower projects:



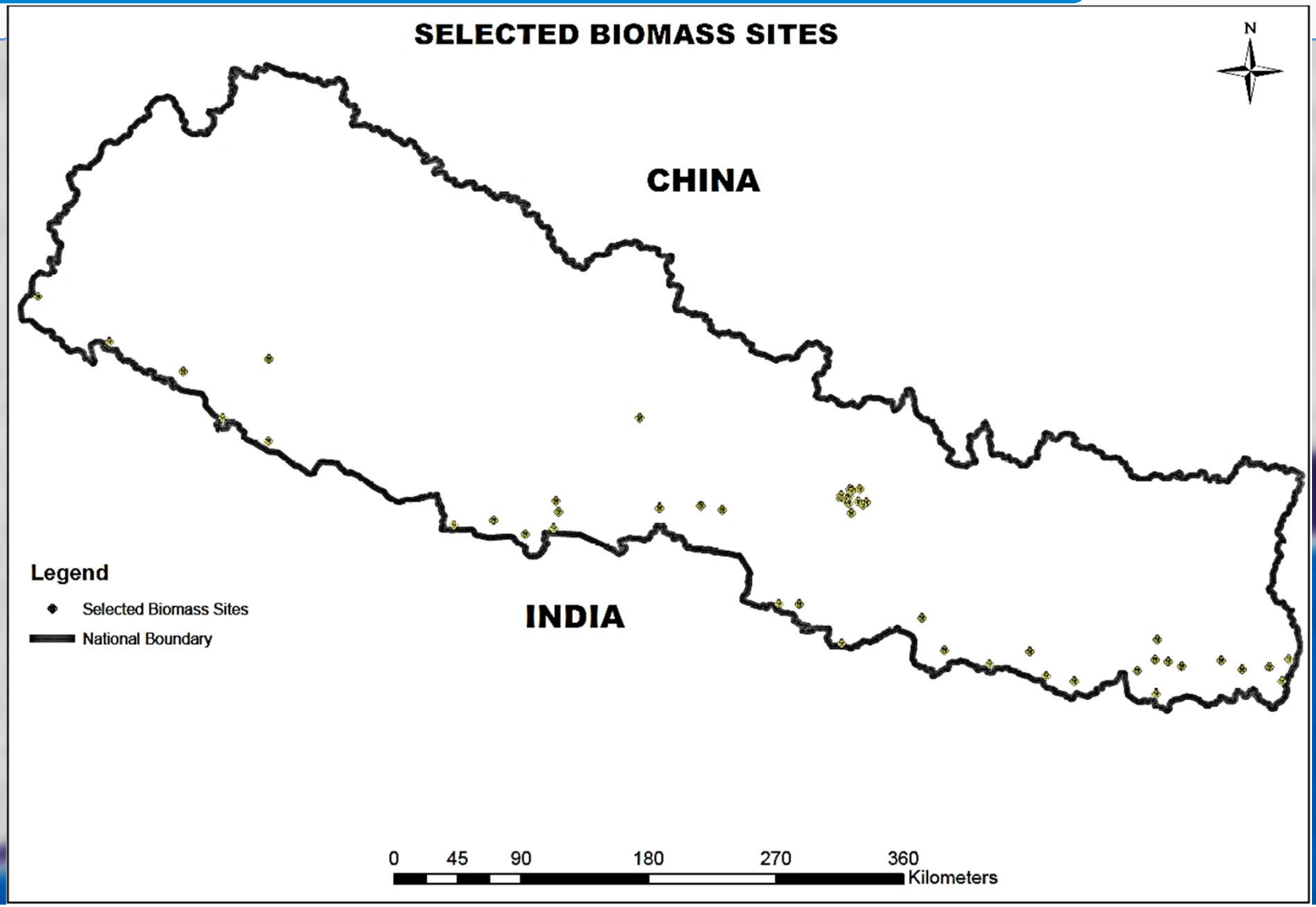
Methodology

Selected DG PV projects:



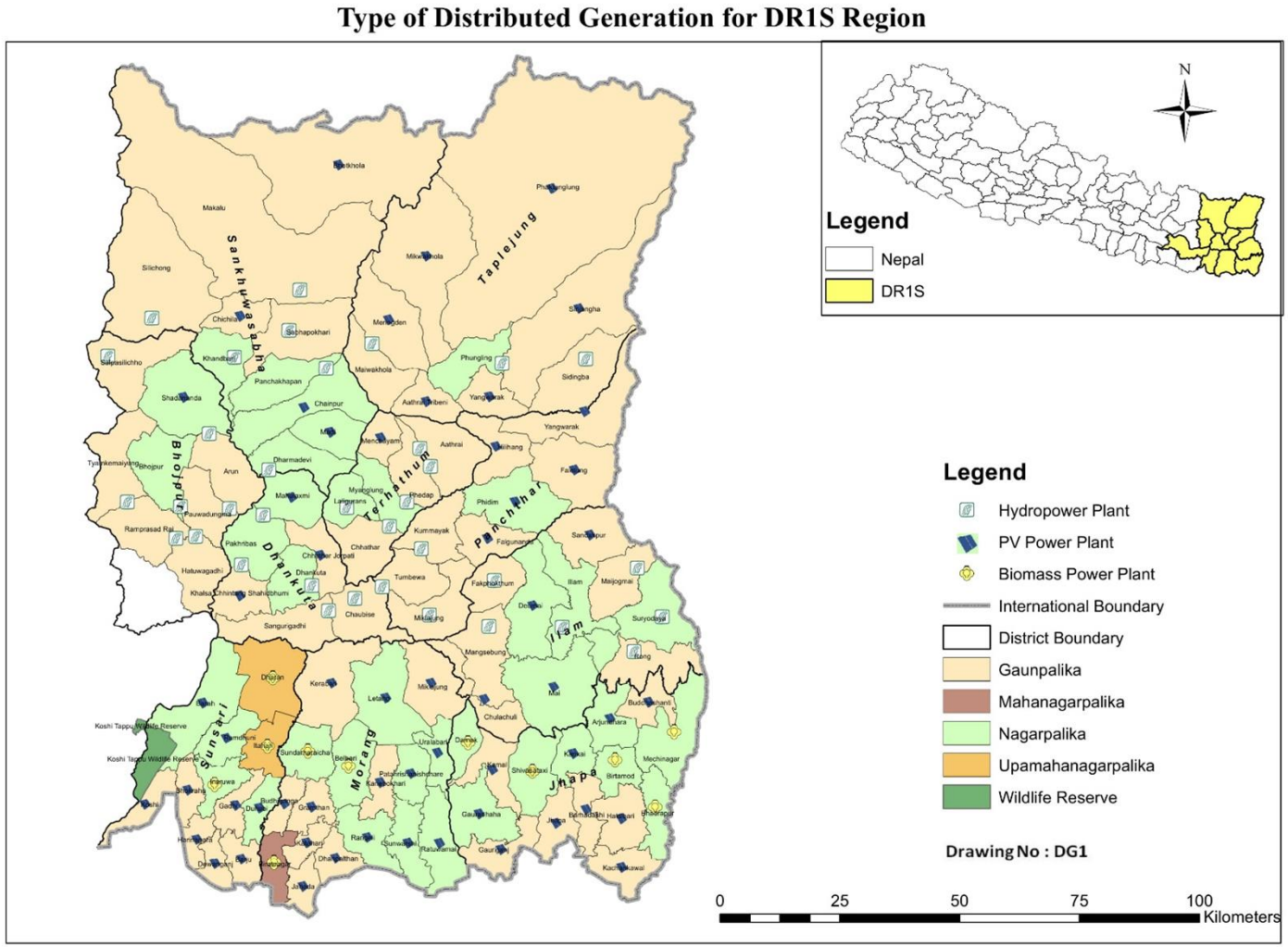
Methodology

Selected DG Biomass projects:



Methodology

Selected DGs, Hydro, Solar, Biomass, Wind

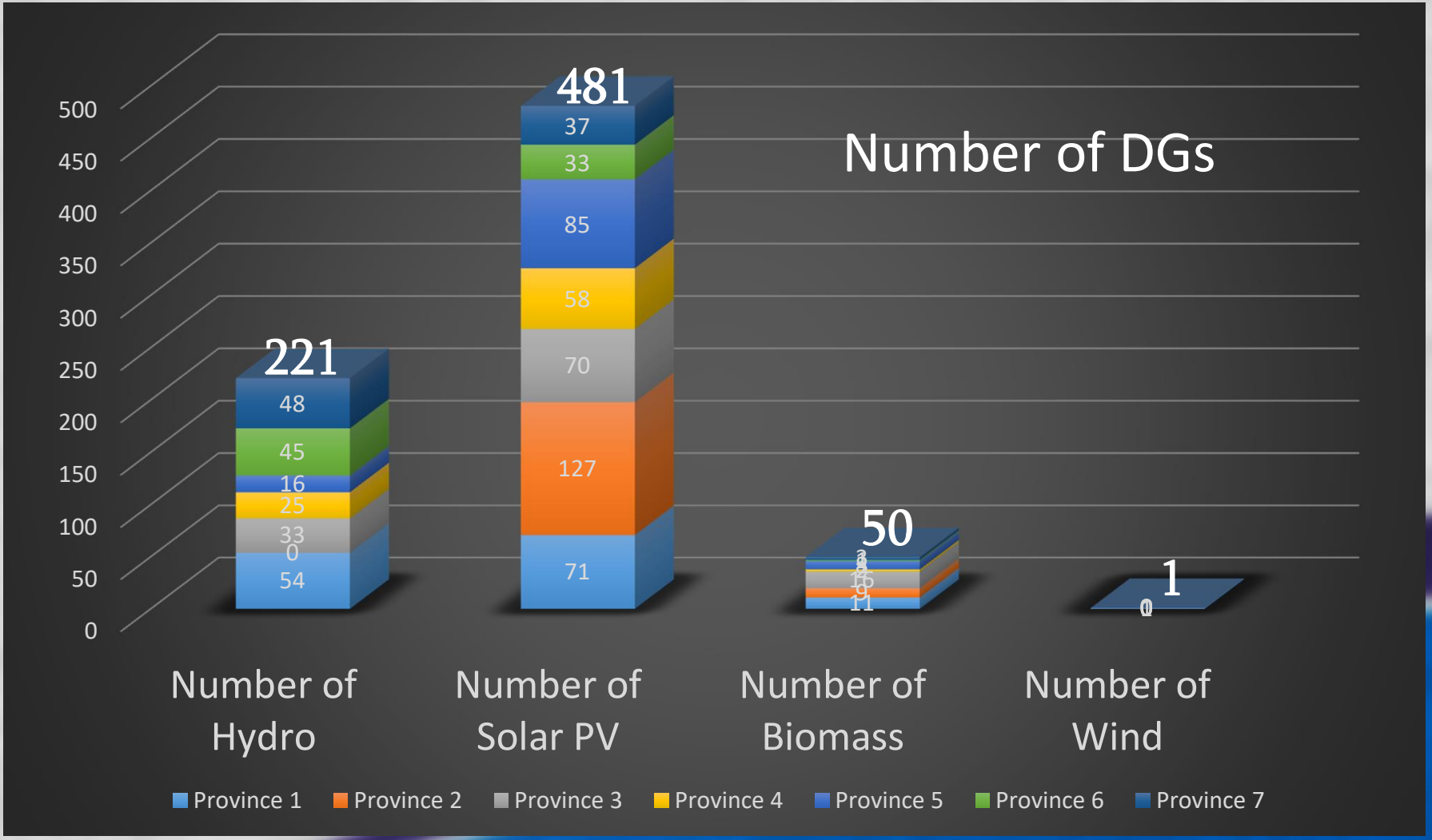


Methodology

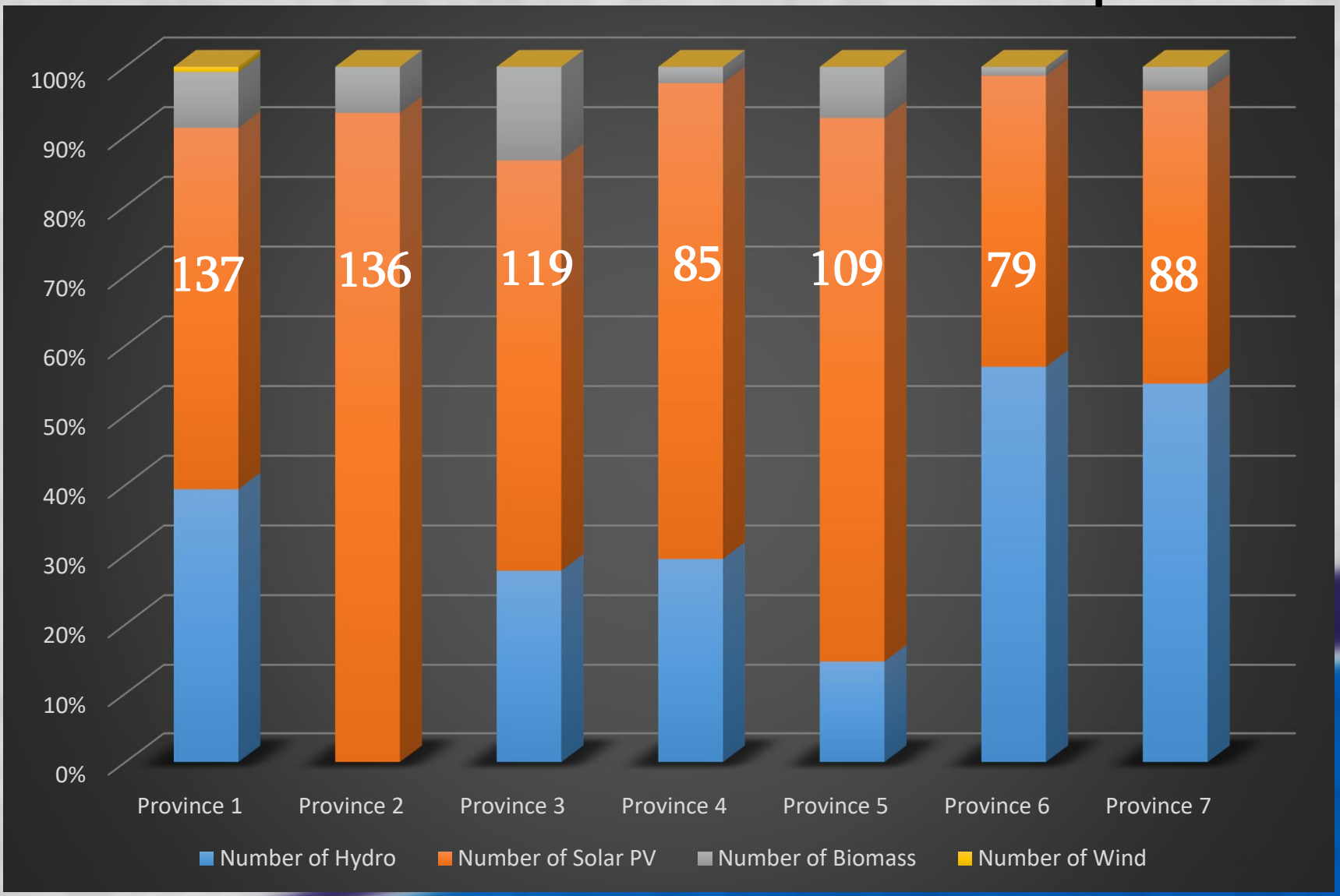
Step 3: Financial Analysis and comparison for Selection of DG projects

- Financial analysis is performed to find the best alternative and determine the necessary investment and subsidy amount
- Analysis has been performed at different SDR
- Multiple Funding Possibilities has also been observed

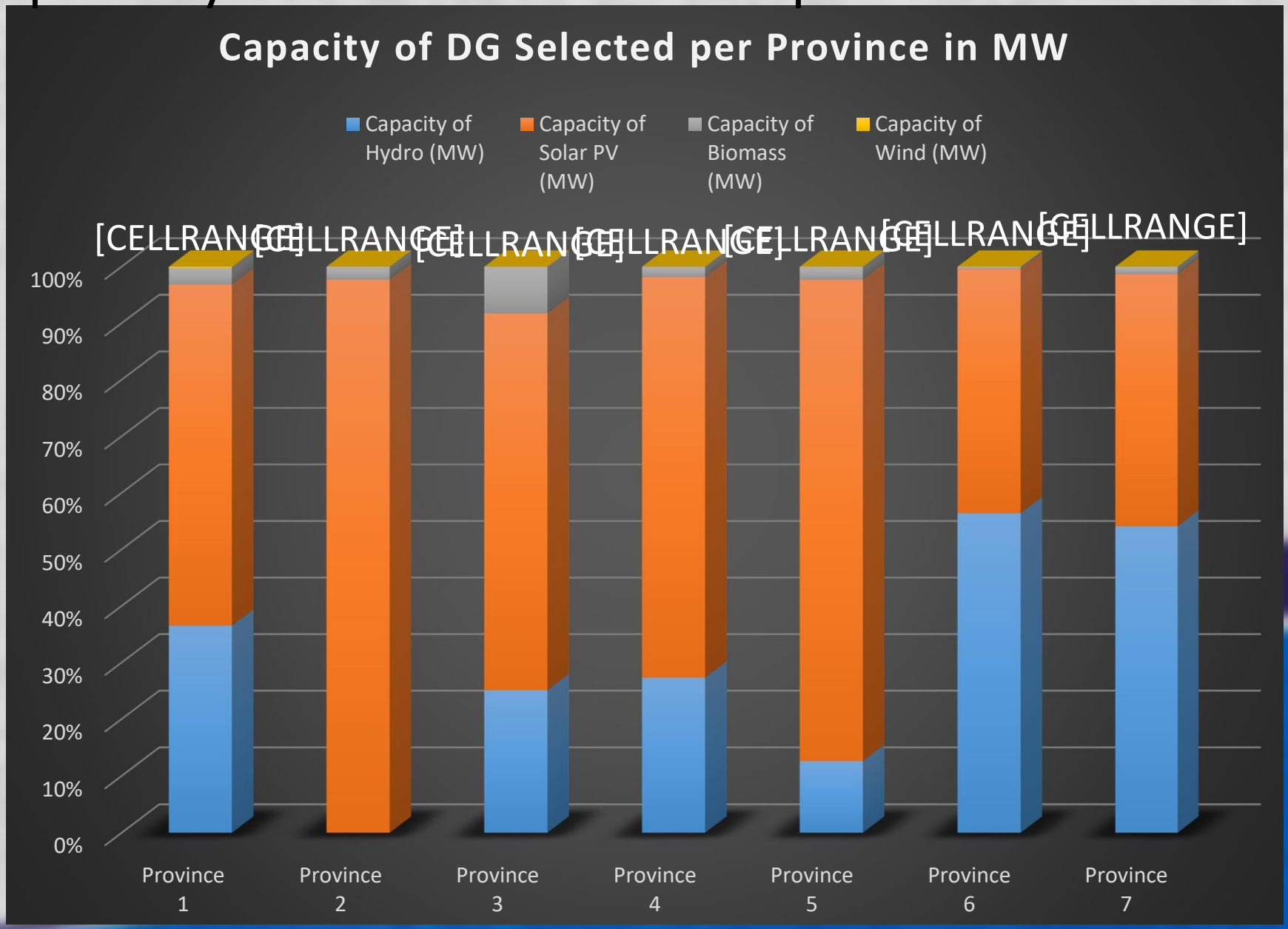
Total Number of DG Selected



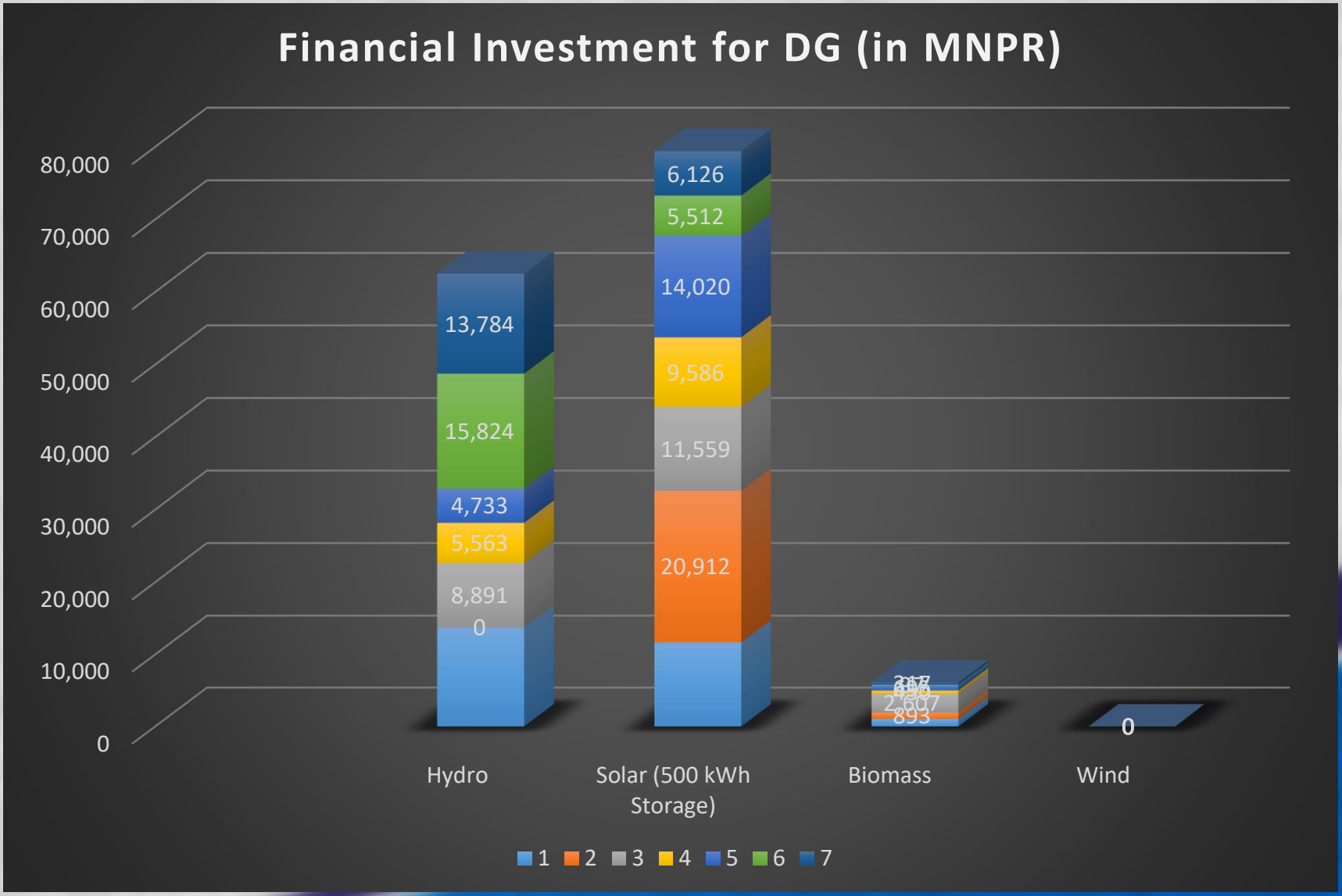
Number of DG Selected per Provi



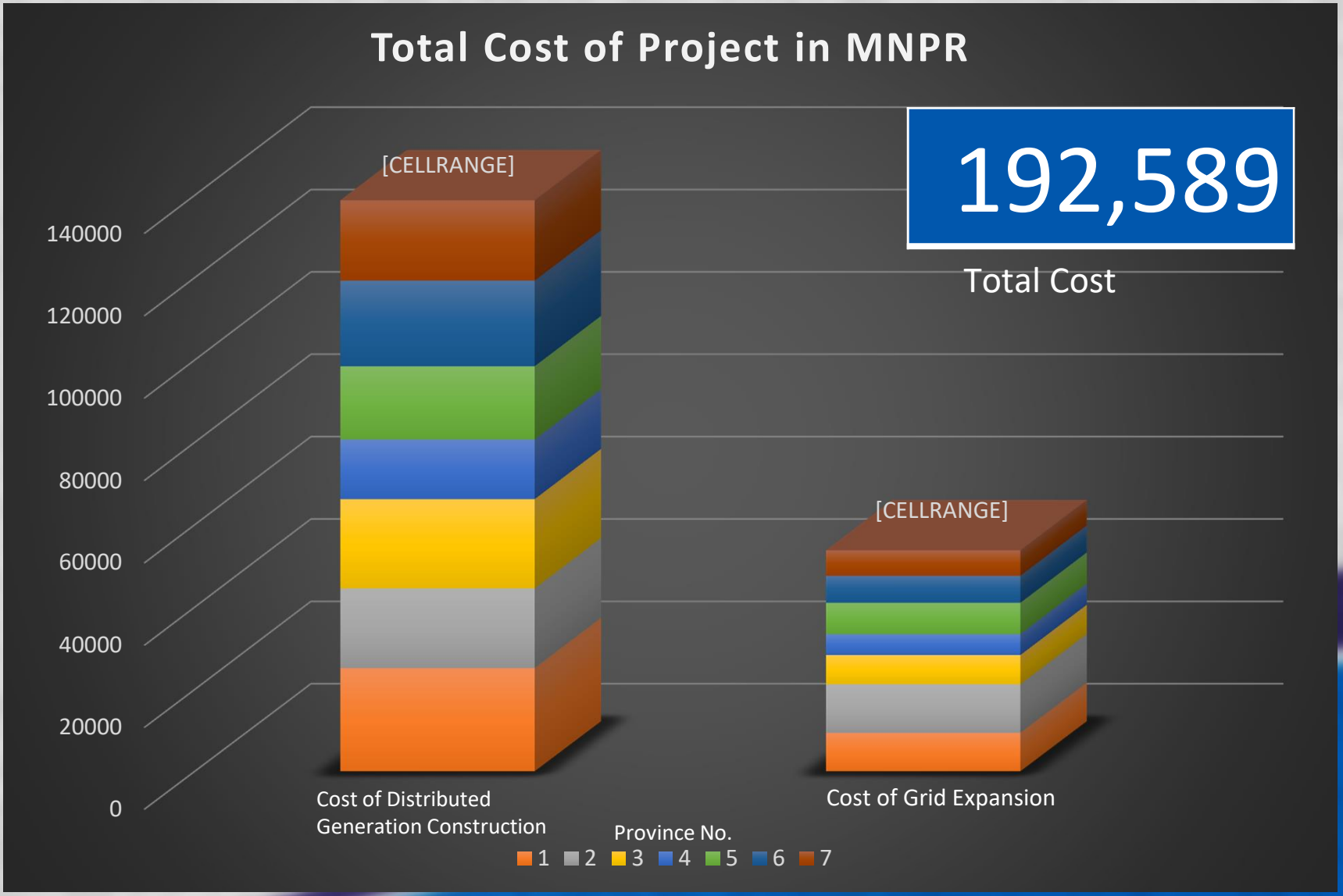
Capacity of DG Selected per Province in MW



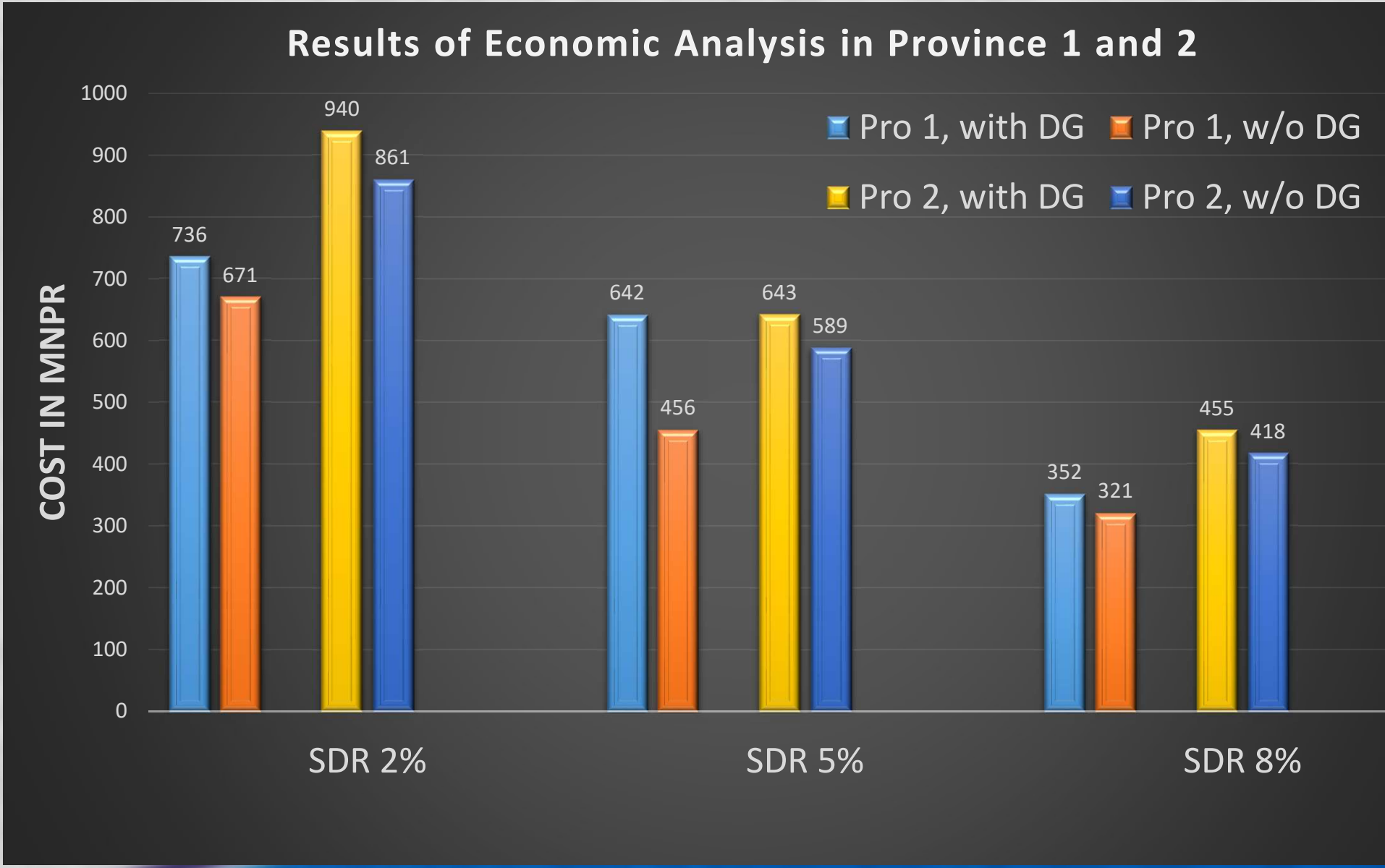
Financial Investment for DG, MNPR



Total Cost of Project, MNPR



Grid Extension with DG vs Without DG



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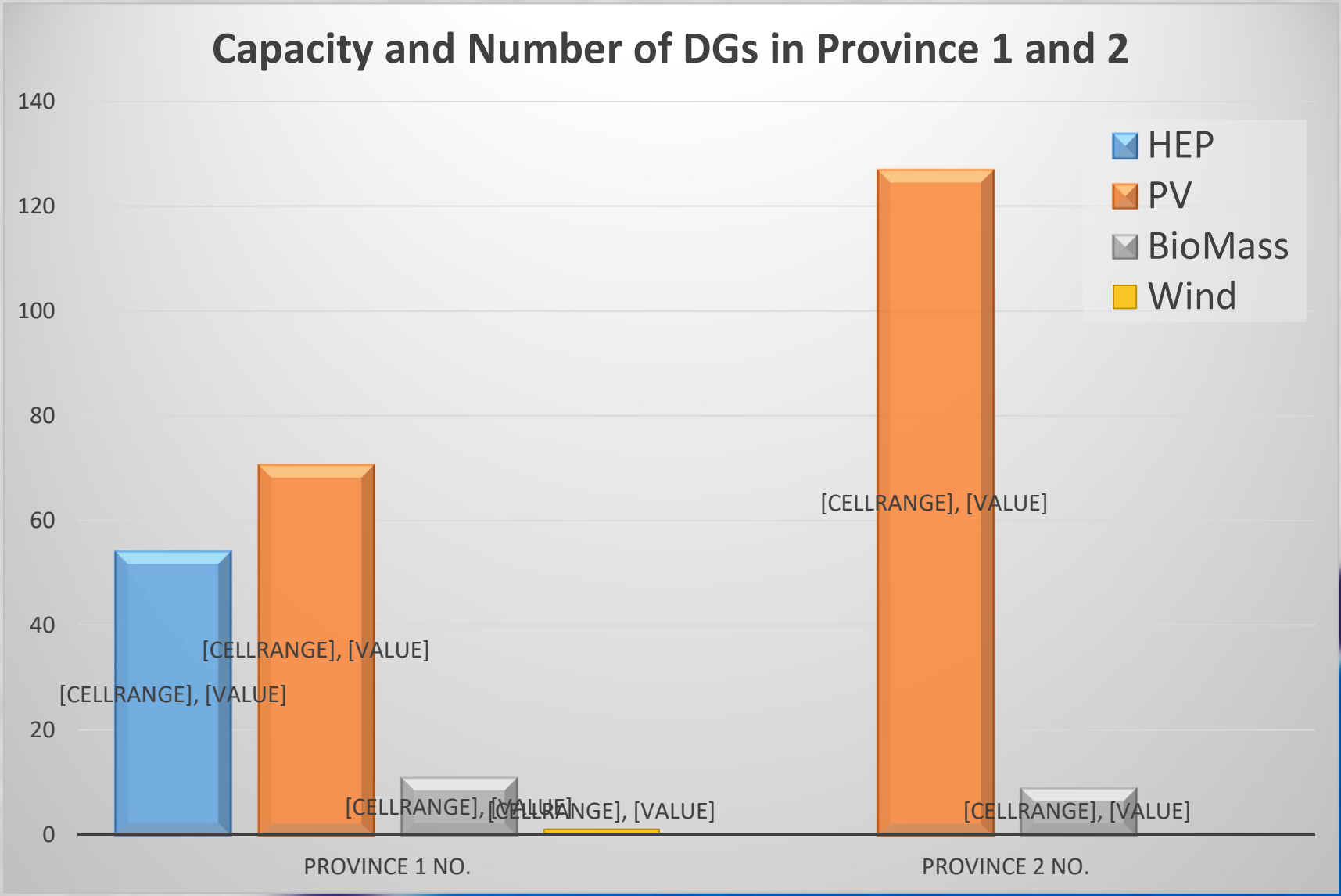
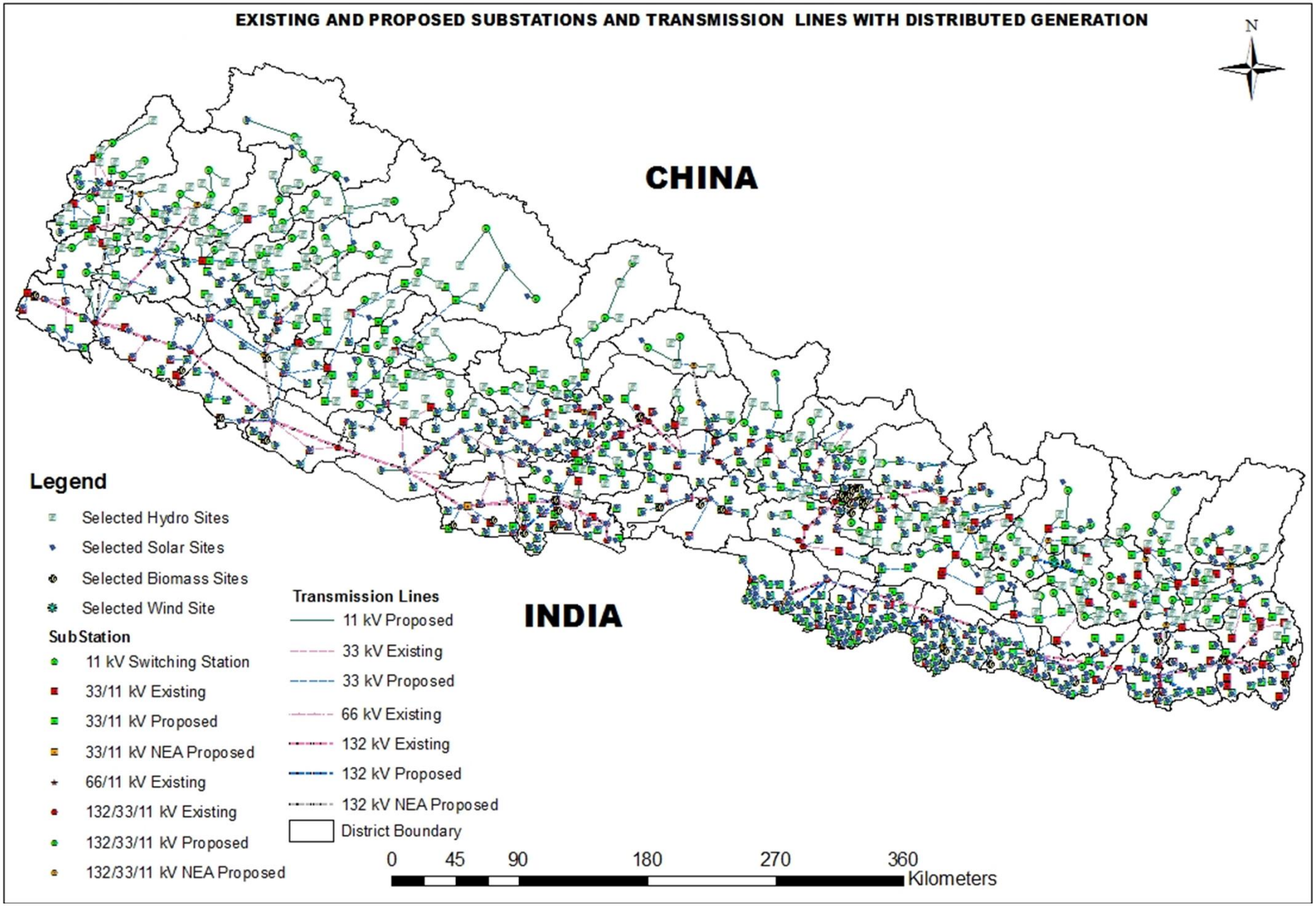


Grid Extension with DG vs Without DG

Effects of DG not monetized

- Use of Natural Resources at Local Level
- Empowerment of local governments
- Local economic impact
- Energy mix
- Distributed job creation
- Ripple Economic Effect: forward linkage to economy such as industrial activity
- Support to local technical capability
- Support to local capital formation by shareholders of local community, as well as local municipality

Recommendations



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Next Steps for Implementation

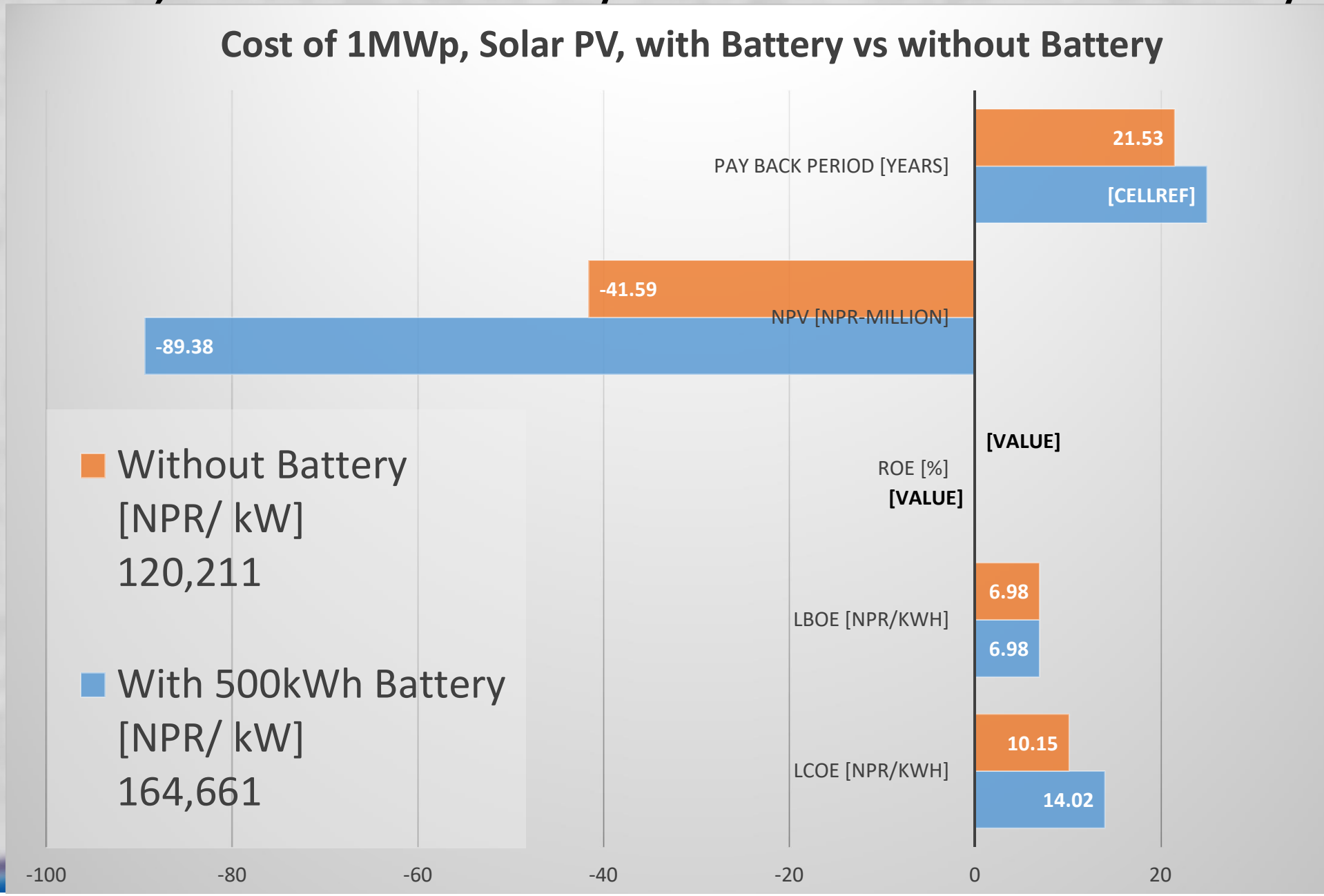
Case I: VGF provided with no upper limit such that ROE = 15% for each Project

Case II: Benchmark VGF provided such that ROE = 15% for each Project with maximum USD 1000/kW (i.e. NPR 100,000/kW) per project

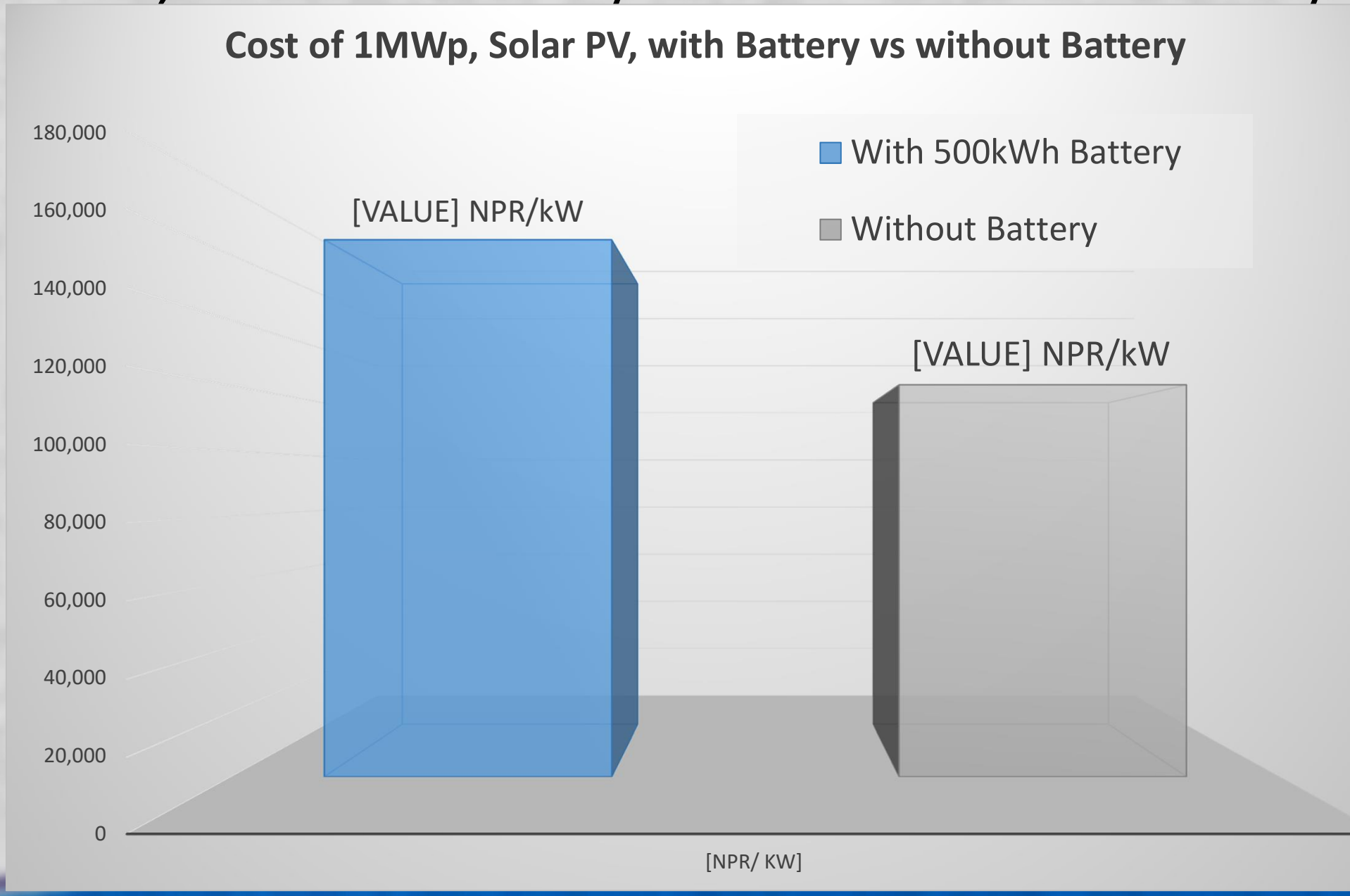
Technology	Case I	Case II
Hydro	USD 229 million	USD 150 million
Solar PV with Battery Storage	USD 519 million	USD 481 million
Biomass	-	
Wind	USD 0.12 million	USD 0.12 million
Country Total	USD 748 million (approx. NPR 75 Arba)	USD 631 million (approx. NPR 63 Arba)

THANK YOU !

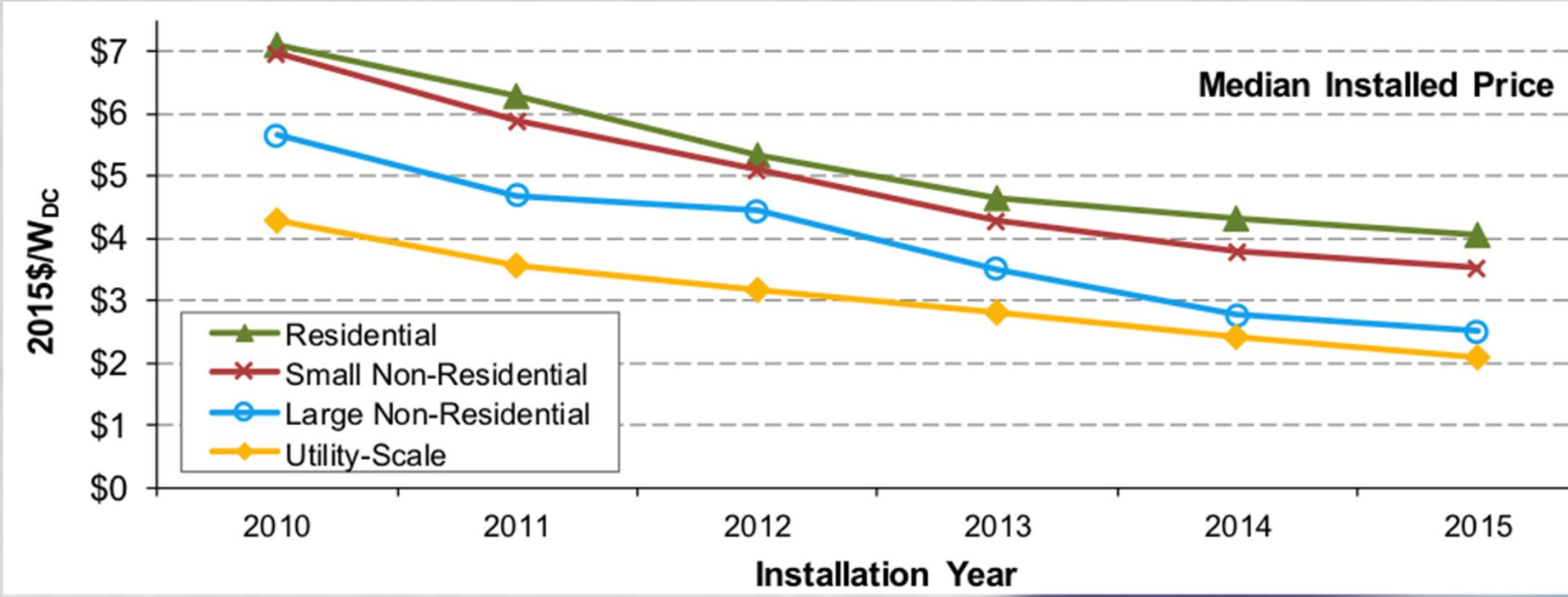
Solar PV, with Battery vs Without Battery



Solar PV, with Battery vs Without Battery



Trend of Solar PV cost



On the other hand, cost of Hydropower is Increasing with increase in cost of Construction Materials

Source: http://newscenter.lbl.gov/2016/08/24/median-installed-price-solar-united-states-fell-