RENEWABLES ON THE RIGHT SPOT: SPATIAL MATCHING MODELS FOR LOW CARBON ENERGY SYSTEM DESIGN

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Introduction: “Renewables on the right spot”

Outline of research

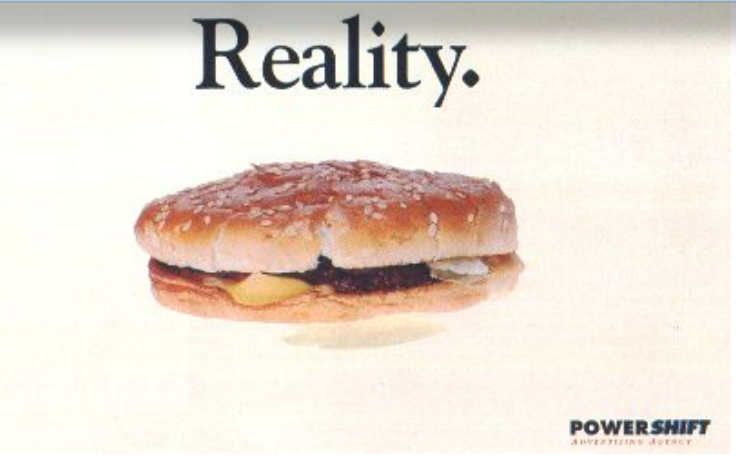
Description of models

- Global renewable energy potential model: protected areas, supply-cost curves, spatial matching.
- Local energy system model: plant location, resource allocation.

Future steps in research

INTRODUCTION: “RENEWABLES ON THE RIGHT SPOT”

Looking forward something in between! = PRACTICAL!

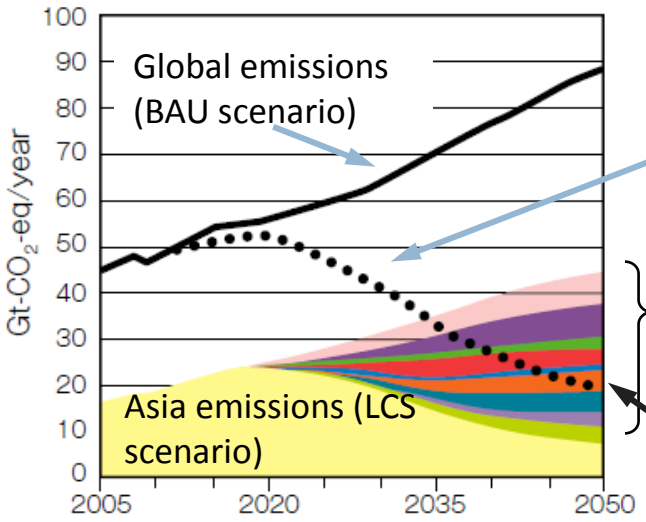


WHY IS NEEDED? PURPOSE?

Source: Asia LCS Research Project leaflet (NIES, 2011)

Low carbon society/energy system

Renewable energy targets



Aspects in assessment of resource potential

Energy system

- Resource
- Technology
- Demand

- Resource flow
- Efficiency of technologies
- Cost
- Location
- Other

Spatial matching

Feedback

OUTLINE OF RESEARCH

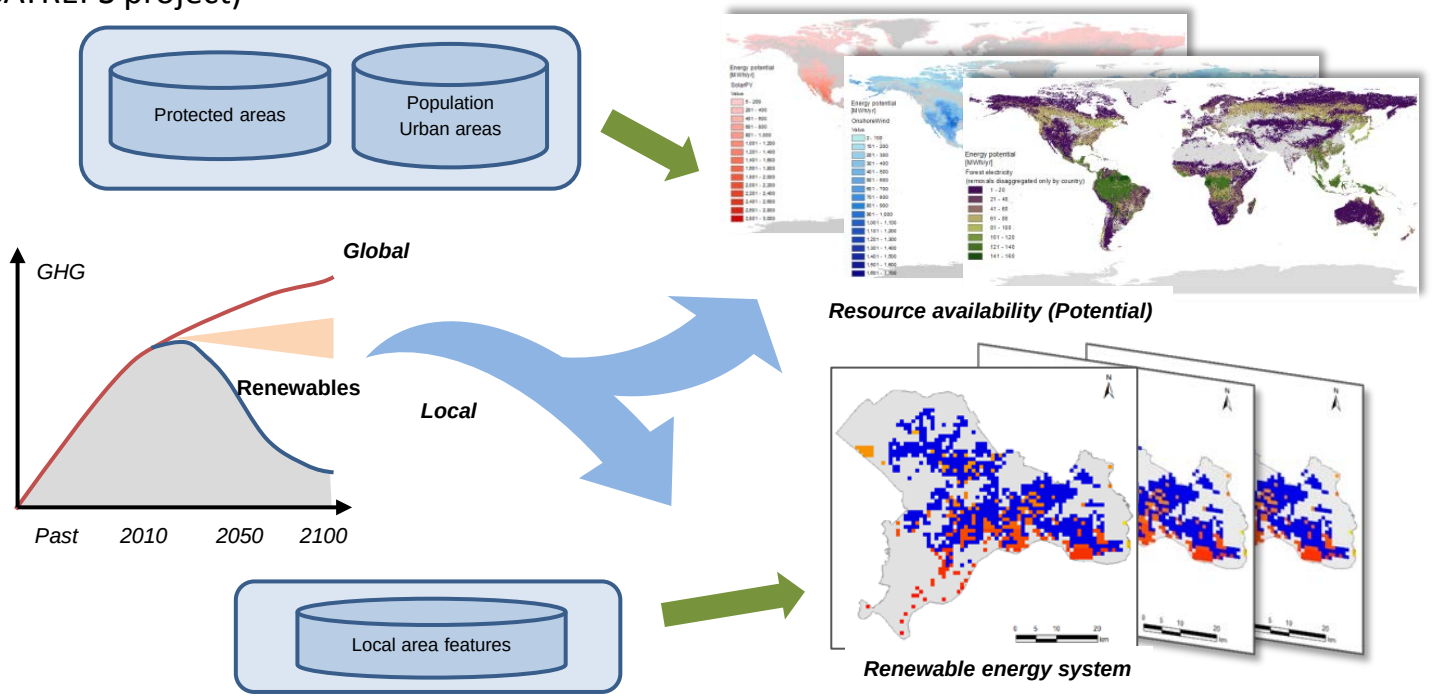
Renewable energy supply using GIS (gridded) data

Global technical potential

- Outputs: technical potential world x35 regions, supply cost curves, maps
- Contribution: integrated models considering renewables, S-6 project

Local energy system model using renewables

- Outputs: optimal mix of renewables in local region,
- Contribution: feasibility of renewable energy targets to policy makers in local areas, Iskandar Malaysia (SATREPS project)



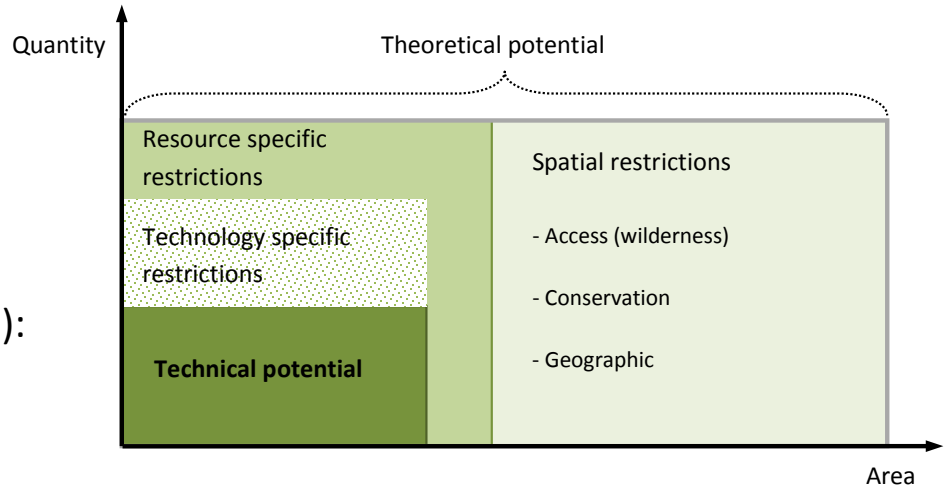
GLOBAL RENEWABLE ENERGY POTENTIAL MODEL

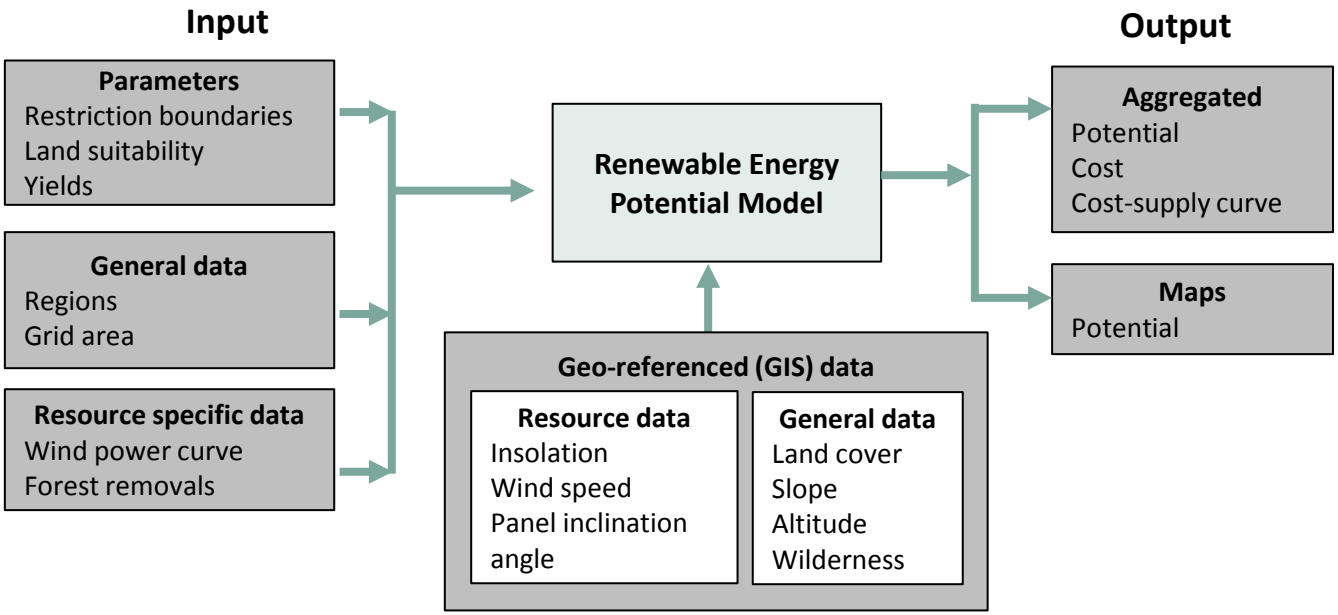
Technical energy potential

Renewable energy

- Solar radiation: solar PV
- Wind speed: onshore wind turbines
- Forest biomass (natural growth, residues): direct combustion in boilers

35 world regions (focus on Asia)





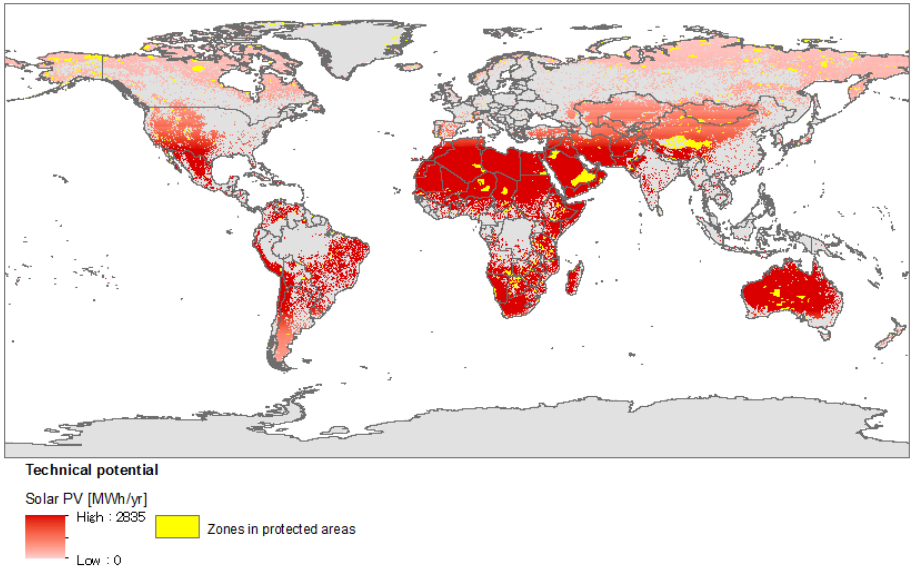
ACCOUNTING FOR NATURAL CONSERVATION (PROTECTED AREAS)

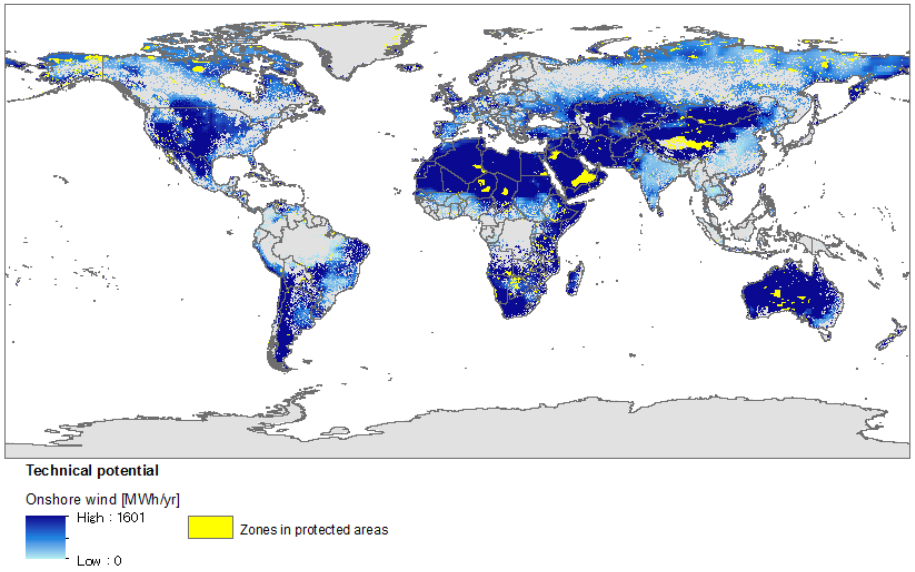
“Loss” in technical potential [MWh/yr]

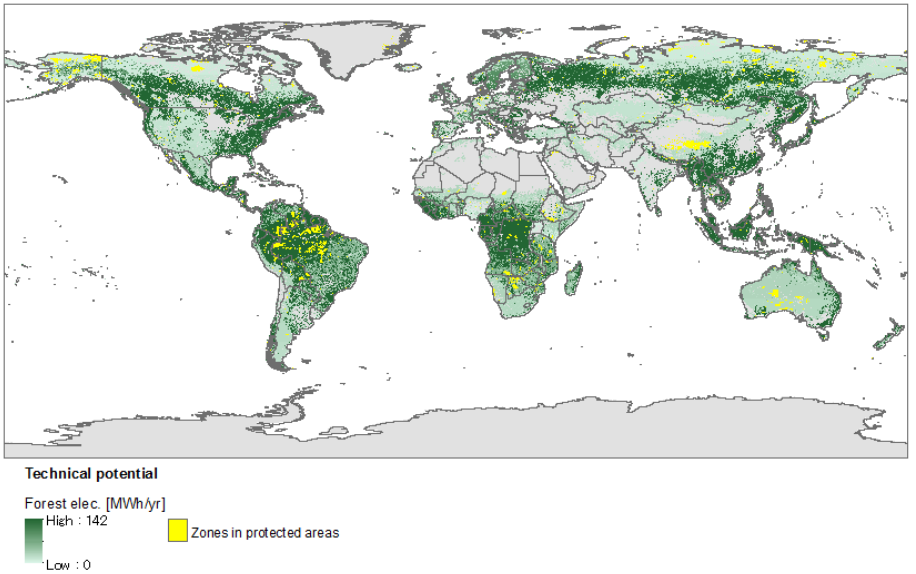
Solar PV = 11%

Onshore wind = 10%

Forest biomass = 17%





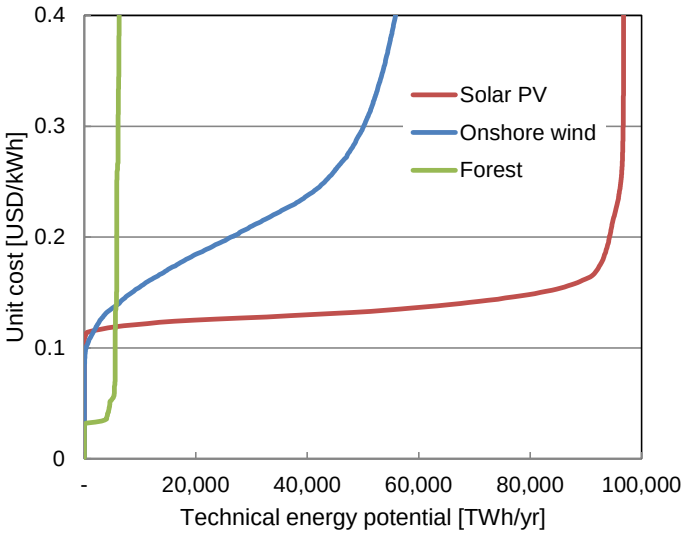


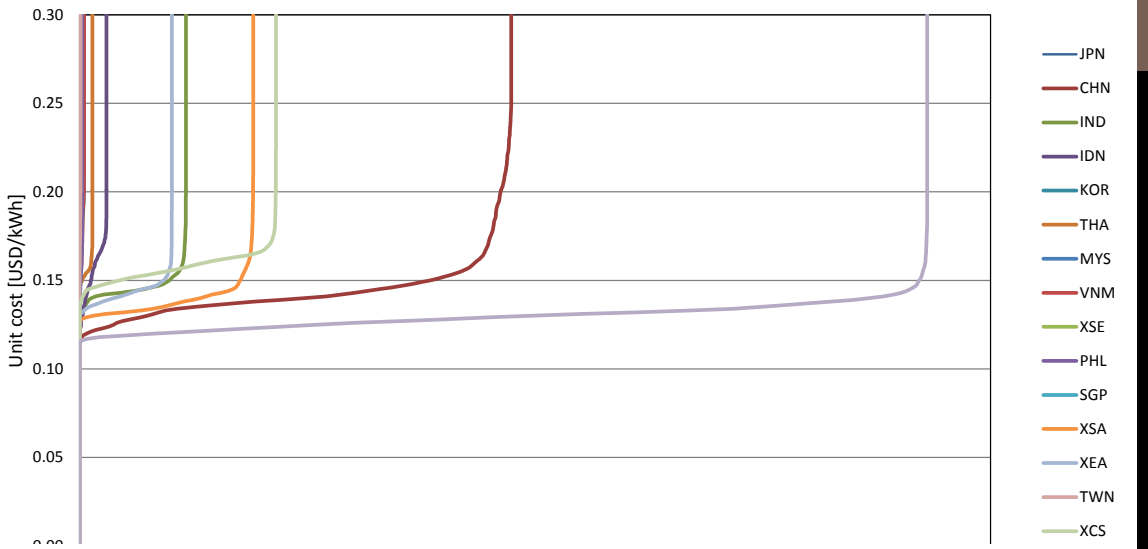
SUPPLY (POTENTIAL) COST CURVES

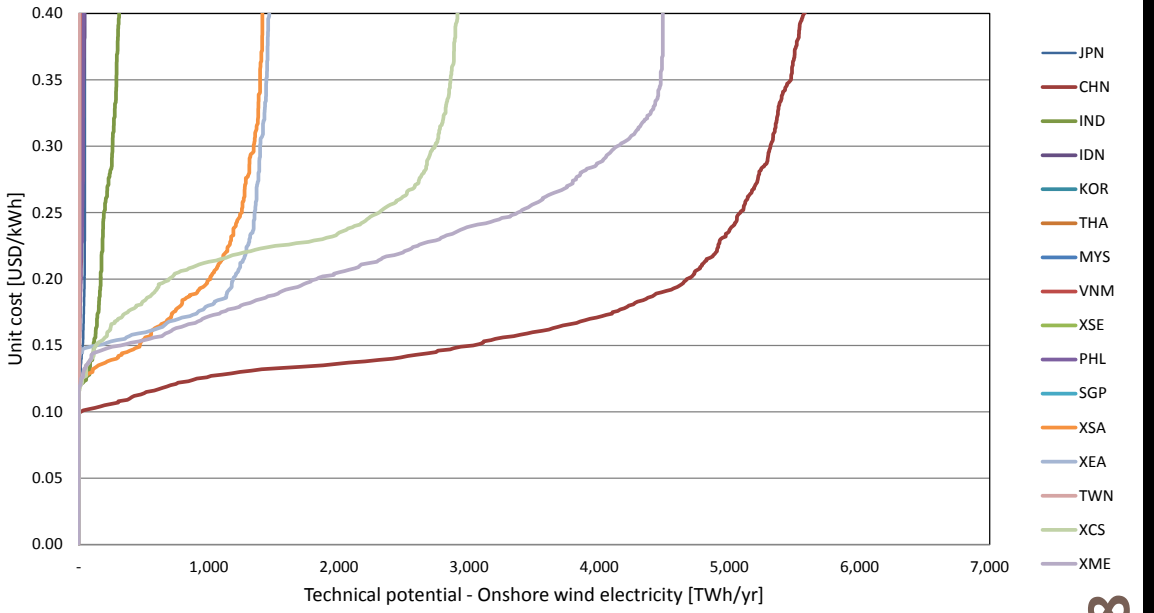
Energy supply

(technical potential) [TWh/yr]

Unit electricity costs [USD/kWh]







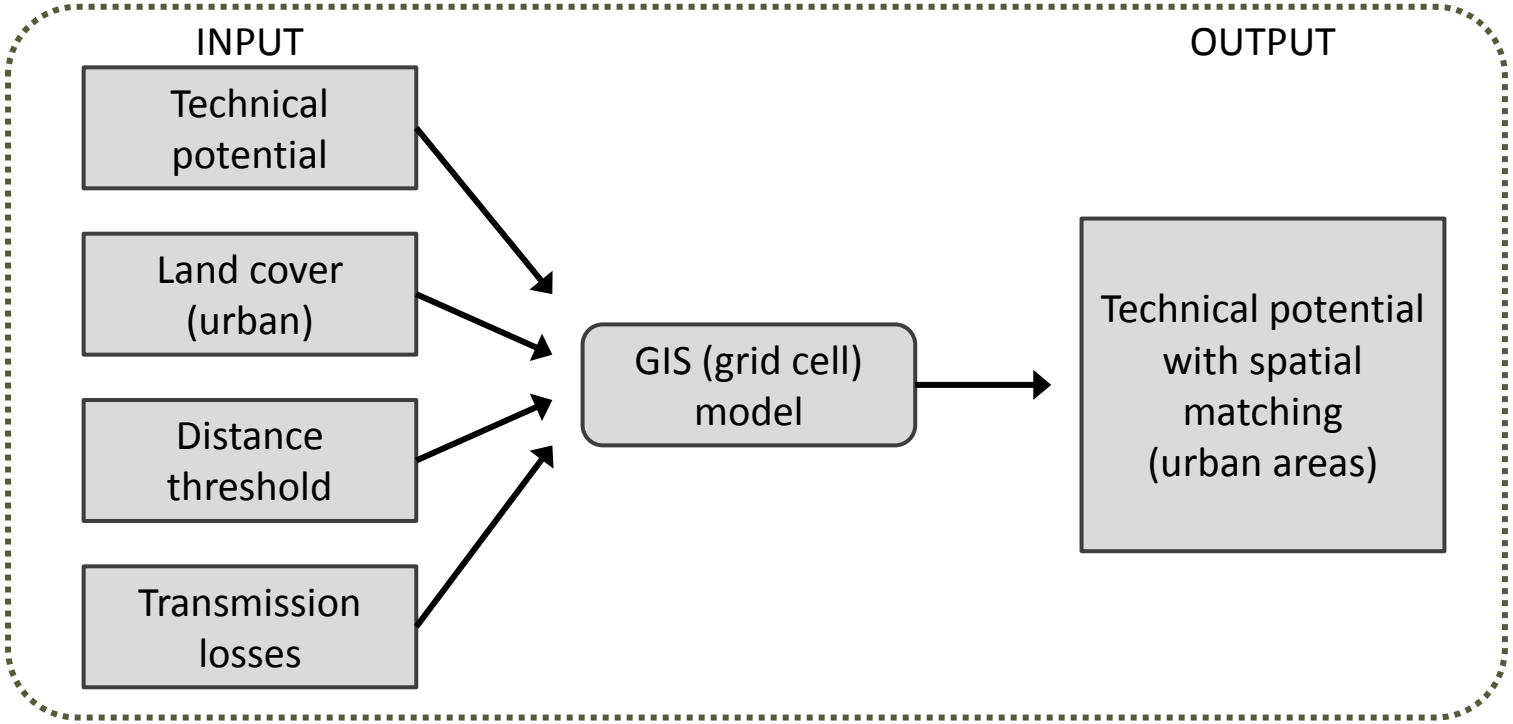
SPATIAL MATCHING IN GLOBAL TECHNICAL POTENTIAL

Spatial matching = Proximity to urban areas

Threshold for distance to urban areas; Transmission losses

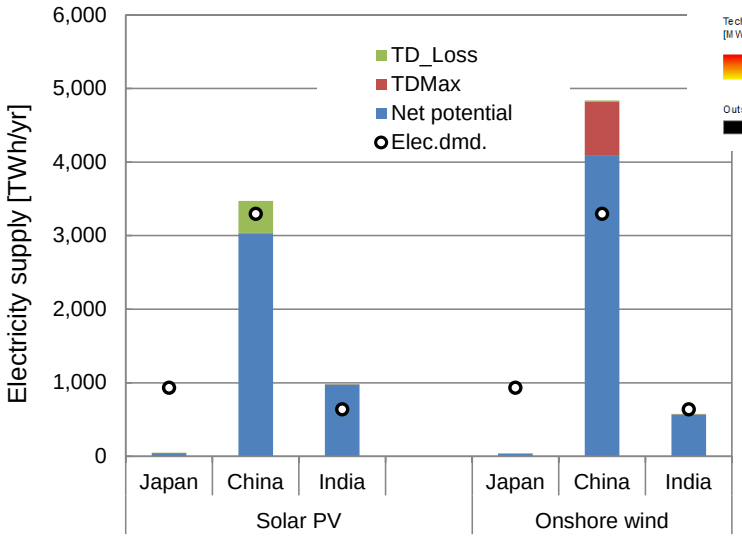
Solar PV and onshore wind electricity generation

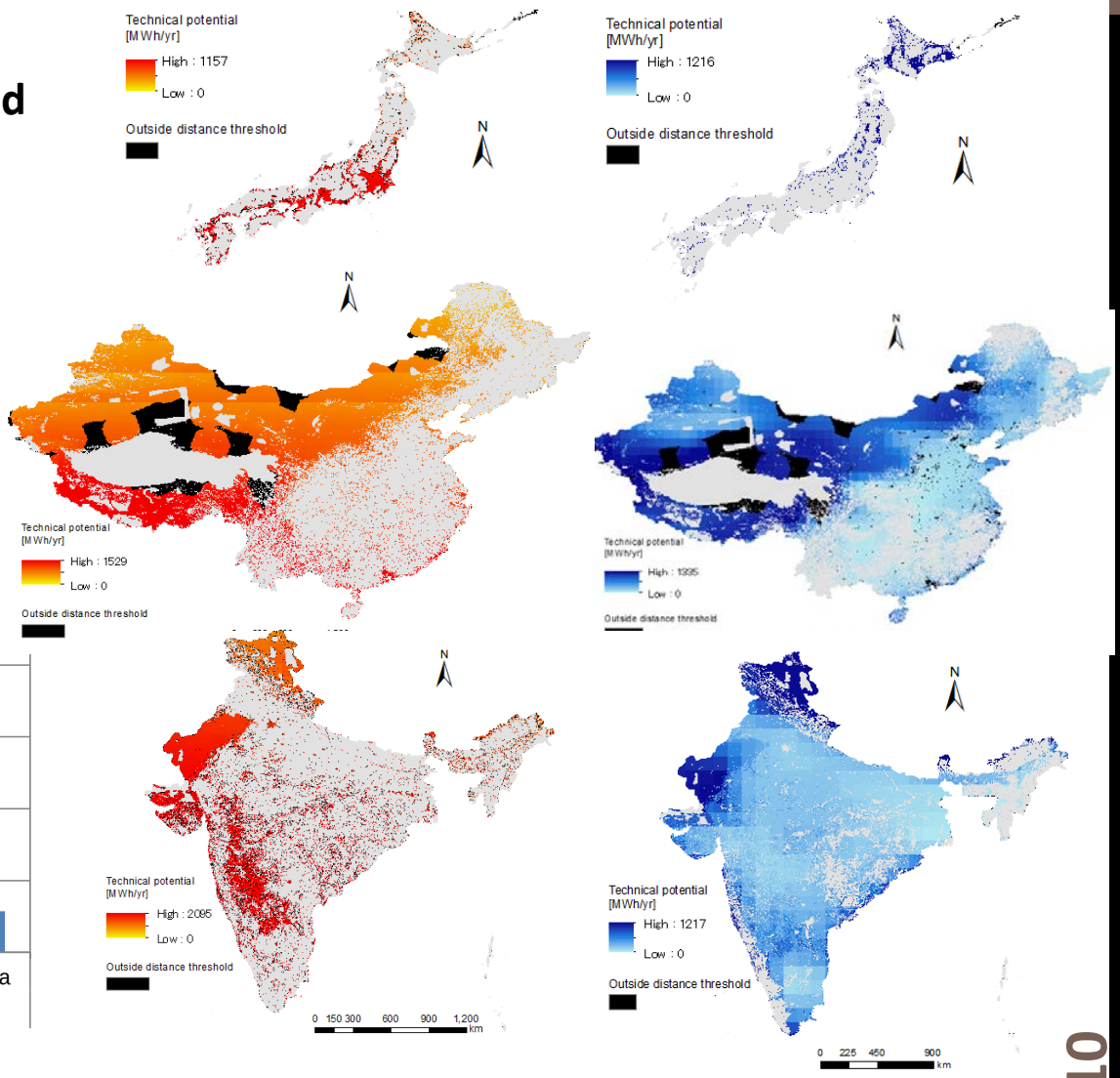
Neglect current electricity transmission networks (grids)



SPATIAL MATCHING IN GLOBAL TECHNICAL POTENTIAL

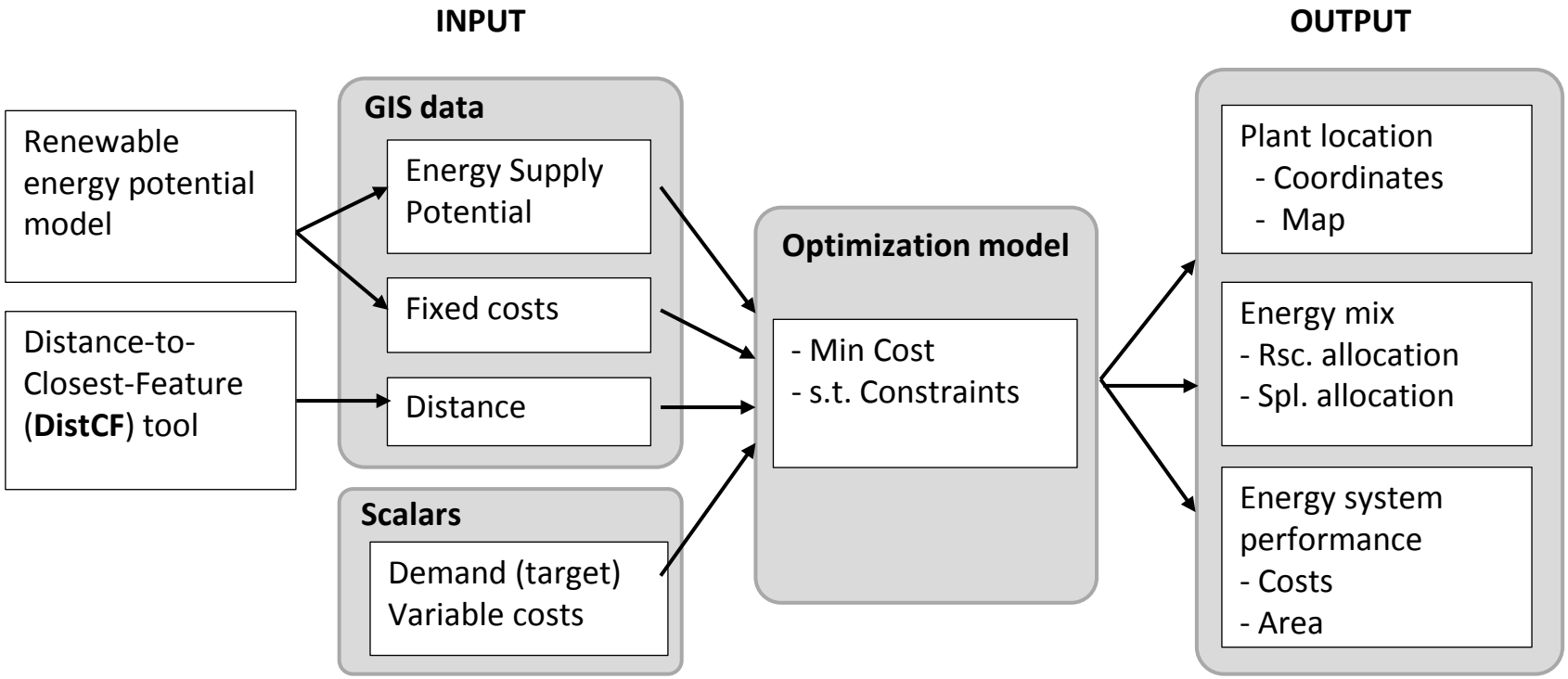
Technical potential of PV and Wind down by 12% and 15% in China





LOCAL ENERGY SYSTEM MODEL USING RENEWABLES

- **Technology (plant site) location + Resource allocation**
- **Optimization: MIP (mixed integer programming)**
- **Objective function: Minimize Total cost**
- **Solved using GAMS (General Algebraic Modeling System)**



Structure of local energy system model

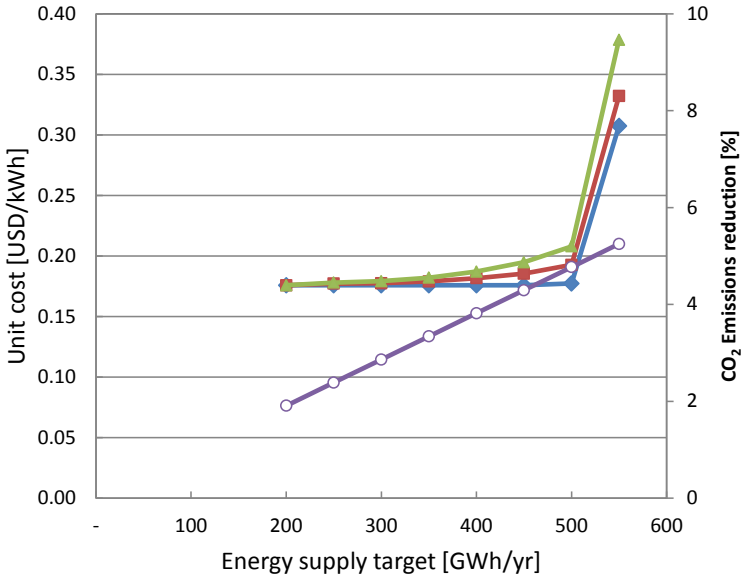
LOCAL ENERGY SYSTEM MODEL – OUTCOMES

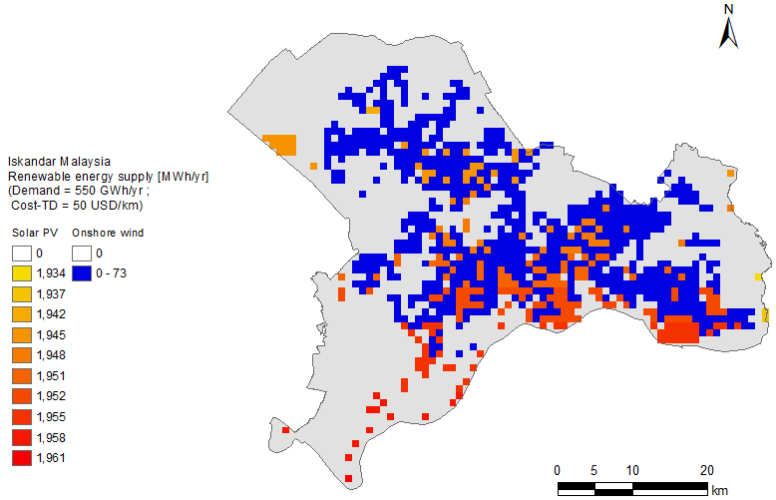
Demand = 550 GWh (i.e. 5% electricity demand)

- PV supply = 91 % (1,941-1,981 MWh/yr/cell)
- Wind supply = 9 % (73 MWh/yr/cell)

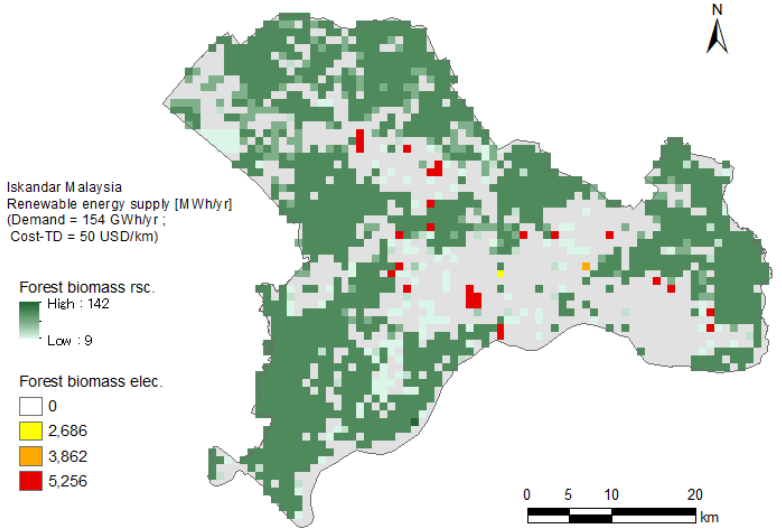
Demand = All forest potential (157 GWh)

- 1.5% of electricity demand





Solar PV + Wind = 5% elec.demand



Forest biomass = 100% forest potential

FUTURE STEPS

Spatial matching in global model

- Proximity to urban areas: Impact on costs?
- Incorporate population and consumption per capita data
- Deployment of renewables based on spatial matching: On-site vs off-site
- Load (electricity demand) matching: compare size of supply and demand for locating plants

Spatial matching in local model

- Generic model formulation
- Incorporate detailed data: land use, renewable resources
- Model application to other regions in Asia

Focus on biomass

- Energy crops

Dynamic aspects of renewable supply

- Scenarios (e.g. land use)

THANK YOU VERY MUCH!

COMMENTS AND QUESTIONS ARE WELCOME!