

THE DPRK ENERGY SECTOR: CURRENT STATUS AND OPTIONS FOR THE FUTURE

**East Asia Energy Futures (EAEF)/Asia Energy
Security Project**

Energy Paths Analysis/Methods Training Workshop

4 to 7 November, 2003, Vancouver, BC, Canada

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OUTLINE OF PRESENTATION:

- Background to DPRK Energy Analyses
 - ◆ History and general analytical approach
- DPRK Energy Balance Update
 - ◆ Overall Approach
 - ◆ Overview of Results: Electricity Supply/Demand
 - ◆ Overview of Results: Other Fuels
- The Potential Role of Energy Efficiency in DPRK Energy Sector Development
 - ◆ Energy, Cost, Environmental Benefits
- Future Energy Paths for the DPRK
- Regional Options/Opportunities in Aiding in DPRK Energy Sector Development
- Analysis Application: Agricultural Sector Needs

PREVIOUS AND ONGOING NAUTILUS INSTITUTE DPRK ENERGY WORK

- ❑ 1986-94: Nuclear Weapons/Proliferation Issues
- ❑ 1992-97: UN Energy-Environment Missions
- ❑ 1995: DPRK Energy Supply/Demand and Energy Efficiency Study
- ❑ 1996: KEDO-HFO Supply and Demand Study
- ❑ 1997: Supply and Demand for Electricity in the DPRK--1990, 1996, and Future Paths
- ❑ 1997: Spent Fuel Scenarios for East Asia
- ❑ 1997-02: DPRK Village Energy Project, Study Tours, and Proposal Collaboration
- ❑ 2002: Update to 2000 base yr (ongoing)

PREVIOUS AND ONGOING NAUTILUS INSTITUTE DPRK ENERGY WORK

□ OVERALL APPROACH TO DPRK ENERGY SECTOR ANALYTICAL WORK

- ◆ Obtain as much **information** as possible about the DPRK economy and energy sector from media sources, visitors to the DPRK, and other sources
- ◆ Use available information, comparative analysis, and judgment to **assemble a coherent and consistent picture** of the DPRK energy sector
- ◆ Think about **possible future paths** for DPRK energy sector and economy, what changes (national, regional, global) might bring those paths about, what changes might mean at end-use, infrastructure levels

DPRK ENERGY BALANCE UPDATE: KEY CHANGES SINCE 1996

- ❑ A continuing decline in the supply of crude oil from China, reducing DPRK's refinery output
- ❑ Continuing degradation of electricity generation infrastructure due to:
 - ◆ Lack of spare parts, use of aggressive fuels (heavy fuel oil, shredded tires) in boilers designed for low-sulfur coal
- ❑ Continuing degradation of electricity T&D infrastructure
- ❑ Continuing degradation of industrial facilities

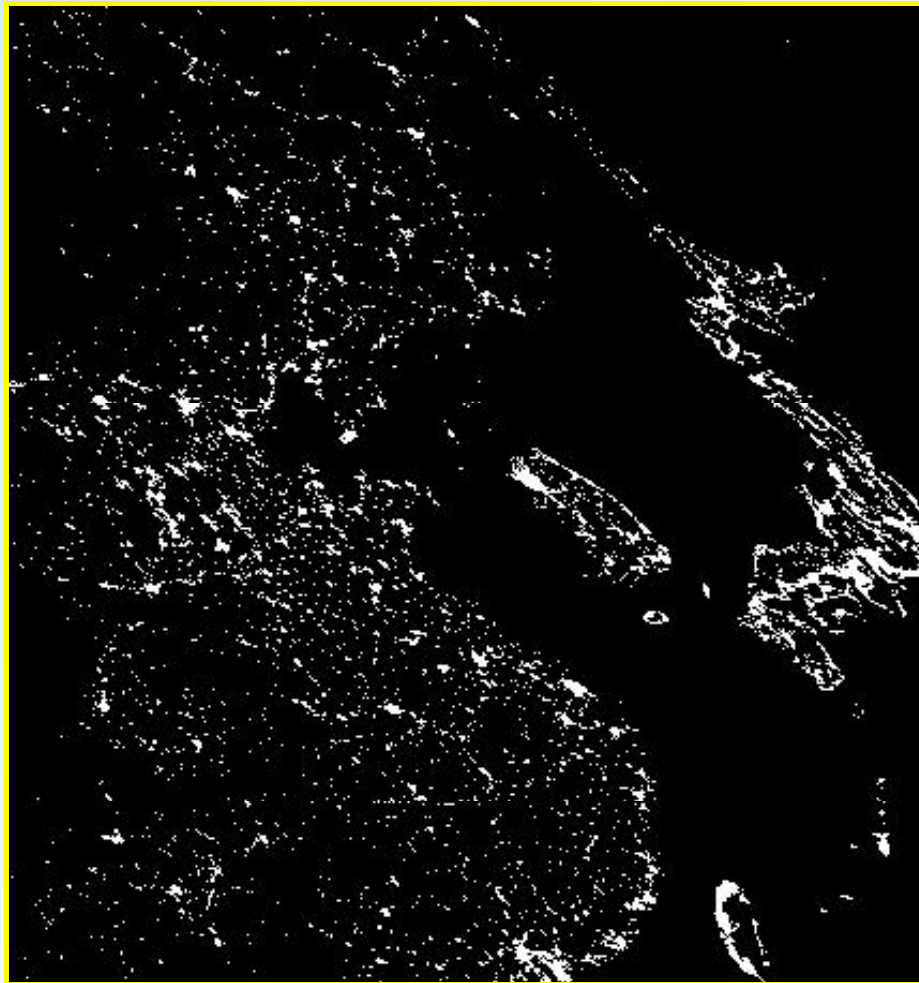
DPRK ENERGY BALANCE UPDATE: KEY CHANGES SINCE 1996

- Continuing degradation of electricity T&D infrastructure
 - ◆ **Much reduced availability of electricity in most parts of the country away from Pyongyang**
- Continuing degradation of industrial facilities
 - ◆ **Eyewitness reports of industrial facilities being dismantled for scrap**
 - ◆ **Damage to operating industrial electric motors from poor quality electricity**

DPRK ENERGY BALANCE UPDATE: KEY CHANGES SINCE 1996

- ❑ Some imports of used motor vehicles Continued decline in cement, steel production
- ❑ Evidence of significant international trade in magnesite (or magnesia)
- ❑ Continuing difficulties with transport of goods
- ❑ Difficulties in coal production
 - ◆ Lack of electricity, mine flooding (Anju region)
- ❑ Some economic revival, but..
 - ◆ Mostly associated with foreign aid and/or economic sectors--such as small markets and cottage industries--that are not energy intensive

DPRK ENERGY BALANCE UPDATE: KEY CHANGES SINCE 1996



DPRK ENERGY BALANCE UPDATE: ELECTRICITY SECTOR RESULTS

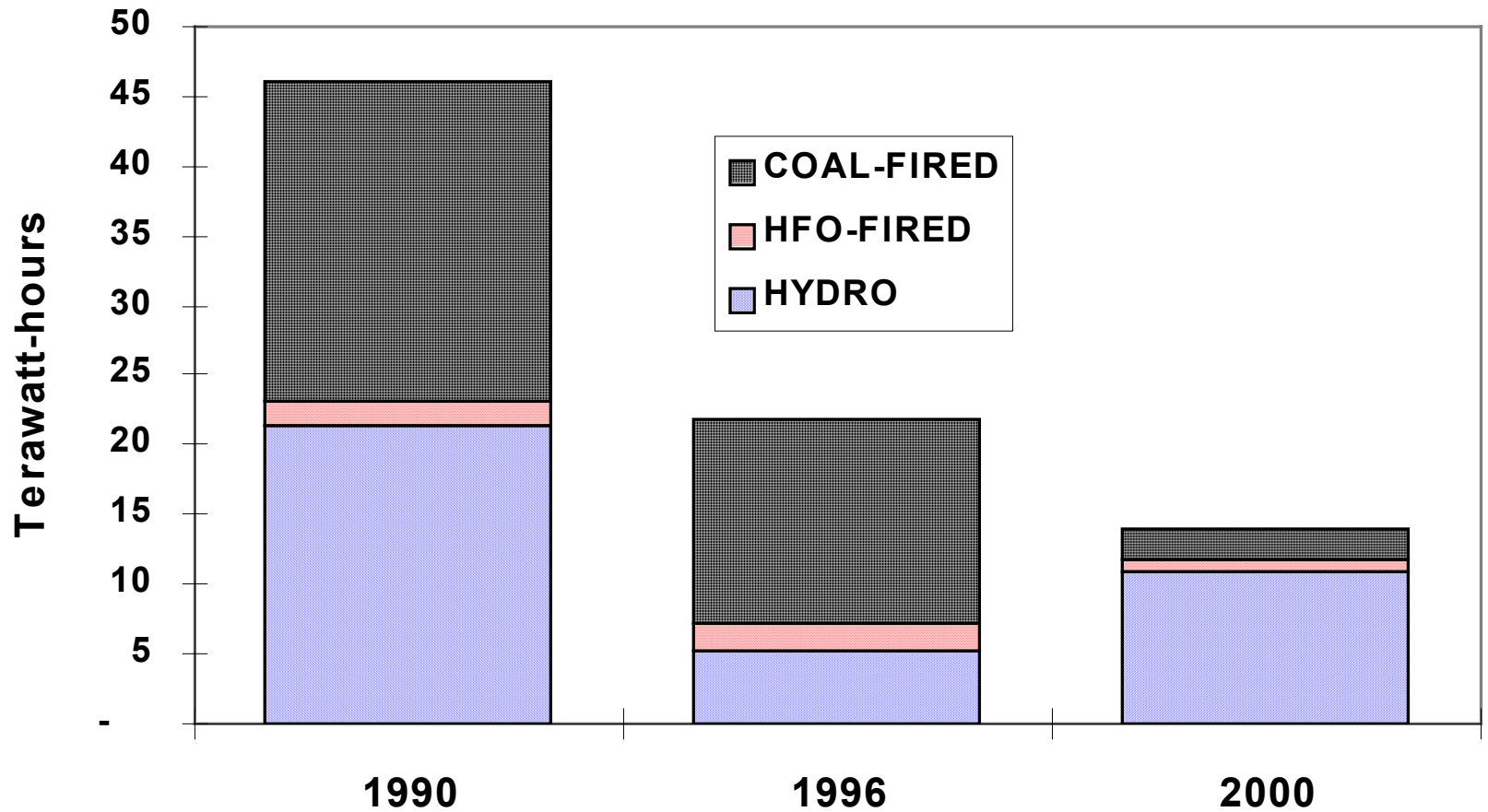
- Thermal generating system eroding rapidly
 - ◆ In most large power stations, only selected boilers and turbines if any, are operating
 - ◆ Problems with "air heaters", resulting in decrease in plant efficiency; problems with boiler tubes
- In total, we estimate less than 800 MW of thermal capacity was operable as of 2000
- Hydroelectric plants have shouldered much of burden of power generation in the DPRK, but...
 - ◆ Hydro availability is highly seasonal: far less power in the dry winter than at other times of the year

DPRK ENERGY BALANCE UPDATE: ELECTRICITY SECTOR RESULTS

- We have assumed that of the ~4000 MW of other hydroelectric plants:
 - ◆ 80% of capacity is operable
 - ◆ Capacity factor in 2000 of about 38 percent
- Major "Youth Dam" including a tunnel system for carrying water has recently been completed, but generating capacity is unclear (200 MWe?).
- New Taedong dam for Southwest Coast irrigation?

DPRK ENERGY BALANCE UPDATE: ELECTRICITY SECTOR RESULTS

Gross Generation in the DPRK, 1990, 1996, and 2000



DPRK ENERGY BALANCE UPDATE: OTHER SUPPLY DATA/RESULTS

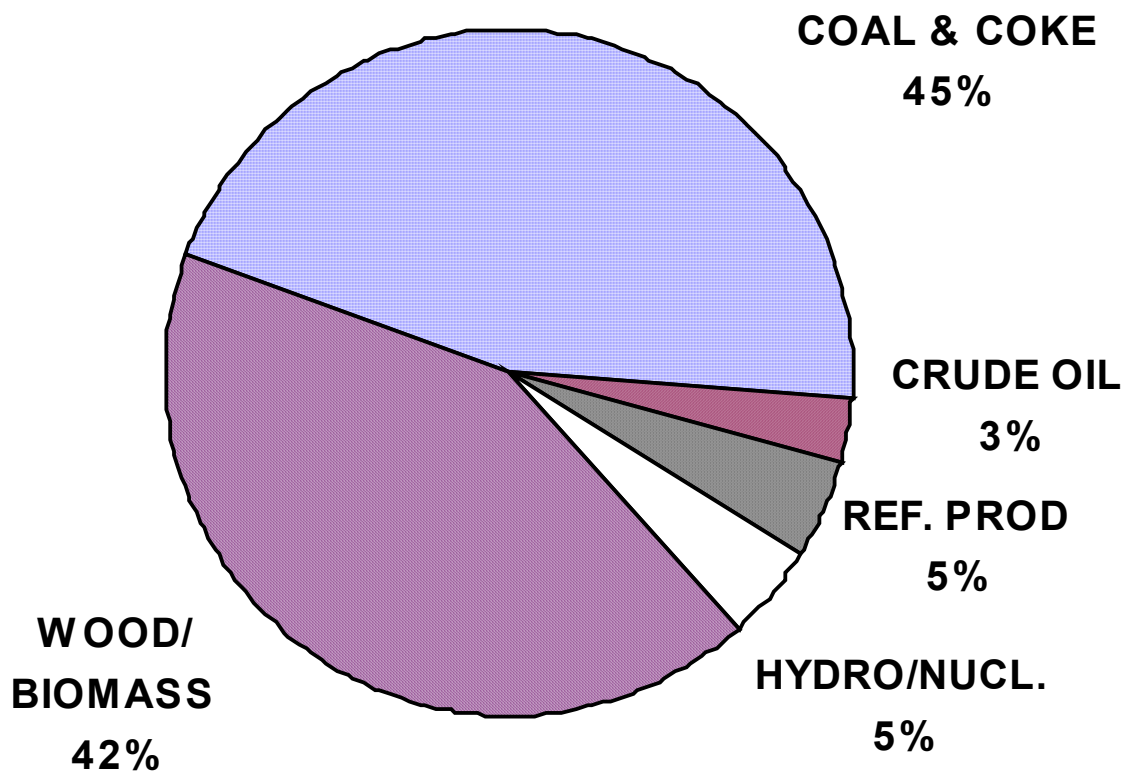
- Coal, biomass resources sufficient for level of production sustained by DPRK infrastructure
- Coal imports: China, 226 kte, Australia, 31kte
- Coal exports (at least) China (8.1 kte), Japan (351 kte)
- Crude oil imports in 2000: 389 kte from China, est. 190 kte from other sources
- Refined products imports to the DPRK from:
 - ◆ ROK, Singapore, Japan, China, Russia, KEDO
 - ◆ Chinese refinery on border (~300 kte)

DPRK ENERGY BALANCE UPDATE: OTHER SUPPLY DATA/RESULTS

- DPRK crude oil production off Sukchon County reported, but it seems likely that any output, if it did occur, was minimal
- Estimated 25,000 tonnes of used tires from Japan, Taiwan for use as boiler fuel (cargoes from Europe reportedly also requested)

DPRK ENERGY BALANCE UPDATE: OTHER SUPPLY DATA/RESULTS

**ESTIMATED DPRK ENERGY SUPPLY BY
TYPE: 2000**



DPRK ENERGY BALANCE UPDATE: ENERGY DEMAND DATA/RESULTS

□ Industry:

- ◆ Output 18% of 1990 except cement/building materials/other minerals (29%), fertilizers (11%)
- ◆ Average energy intensity 115% 1990 levels

□ Transport:

- ◆ Road freight scales with industrial output
- ◆ Diesel rail freight is assumed to be 30% of 1990 levels, electric rail freight 24% of 1990

DPRK ENERGY BALANCE UPDATE: ENERGY DEMAND DATA/RESULTS

□ Residential:

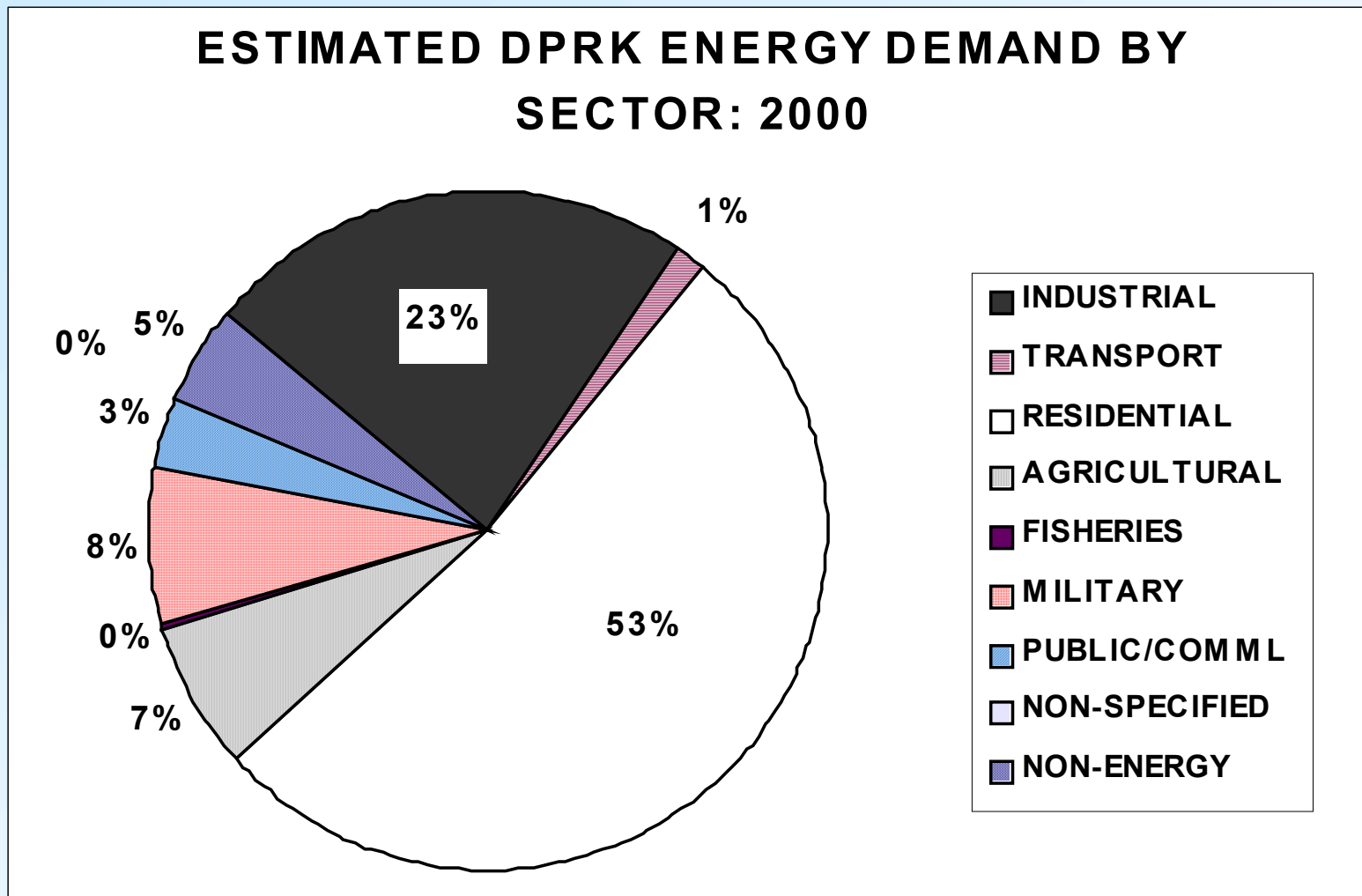
- ◆ Residential coal use ~50% of 1990 levels
- ◆ Based on power availability, electricity use per household about 29% of 1990

□ Agriculture/Fisheries

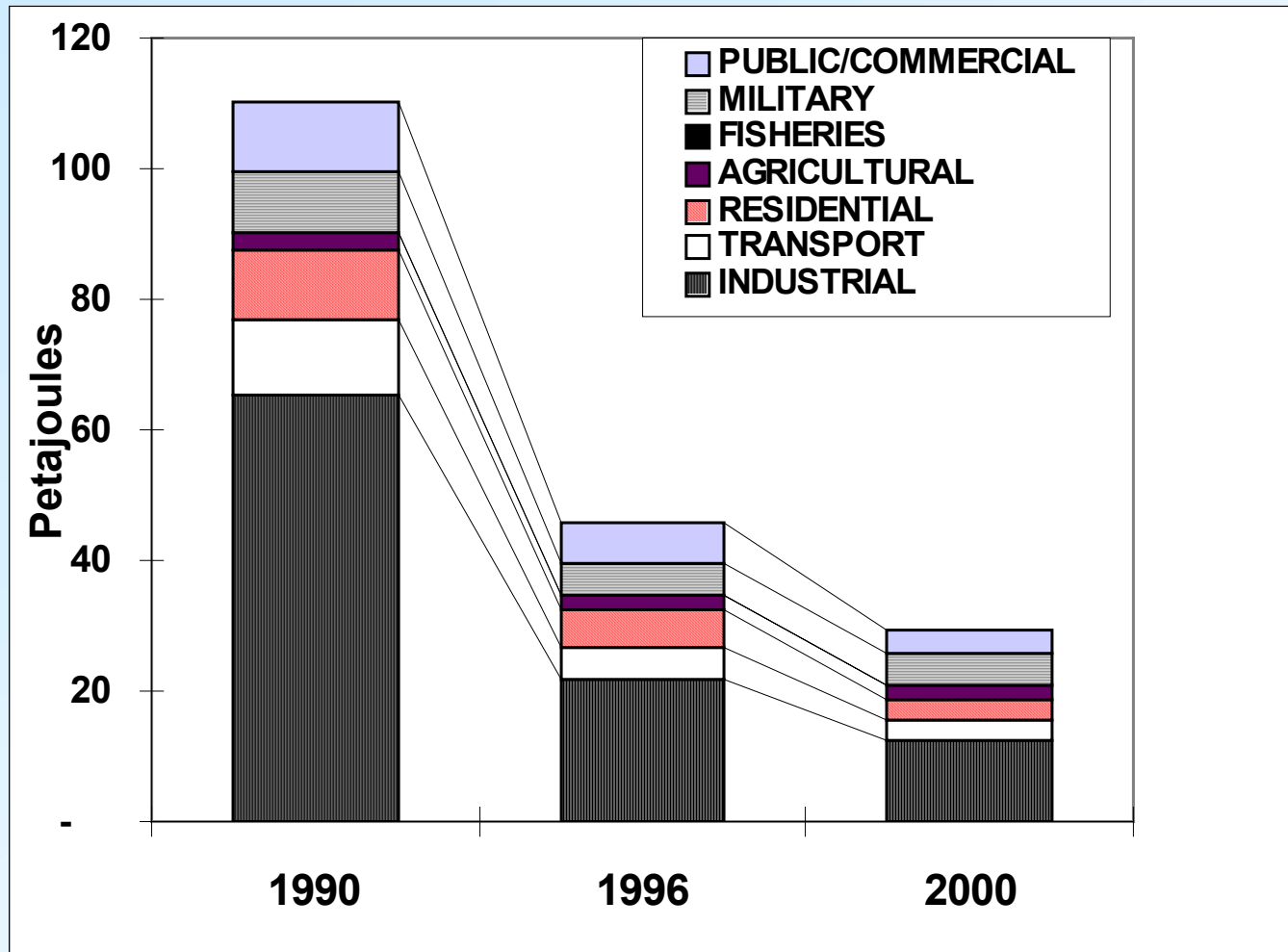
- ◆ Diesel tractor use in 2000 40% of 1990 levels
- ◆ Fisheries marine catch, 42% of 1990 levels

DPRK ENERGY BALANCE UPDATE: ENERGY DEMAND DATA/RESULTS

ESTIMATED DPRK ENERGY DEMAND BY
SECTOR: 2000

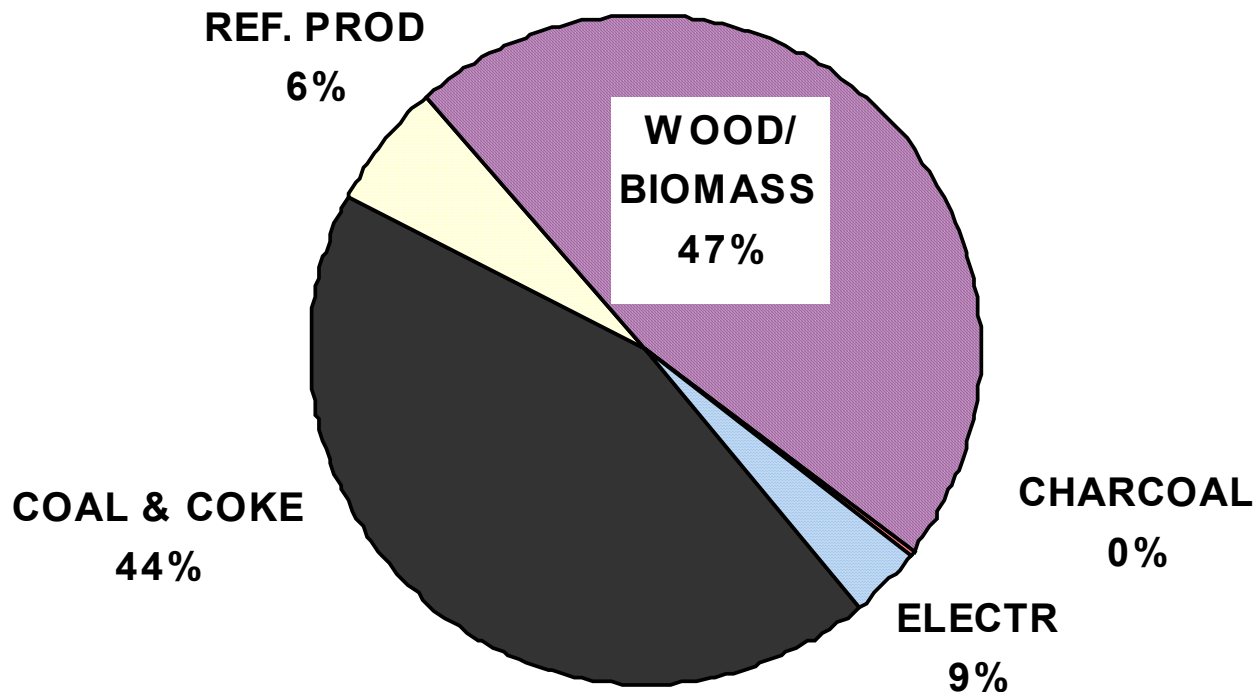


DPRK ENERGY BALANCE UPDATE: ENERGY DEMAND DATA/RESULTS

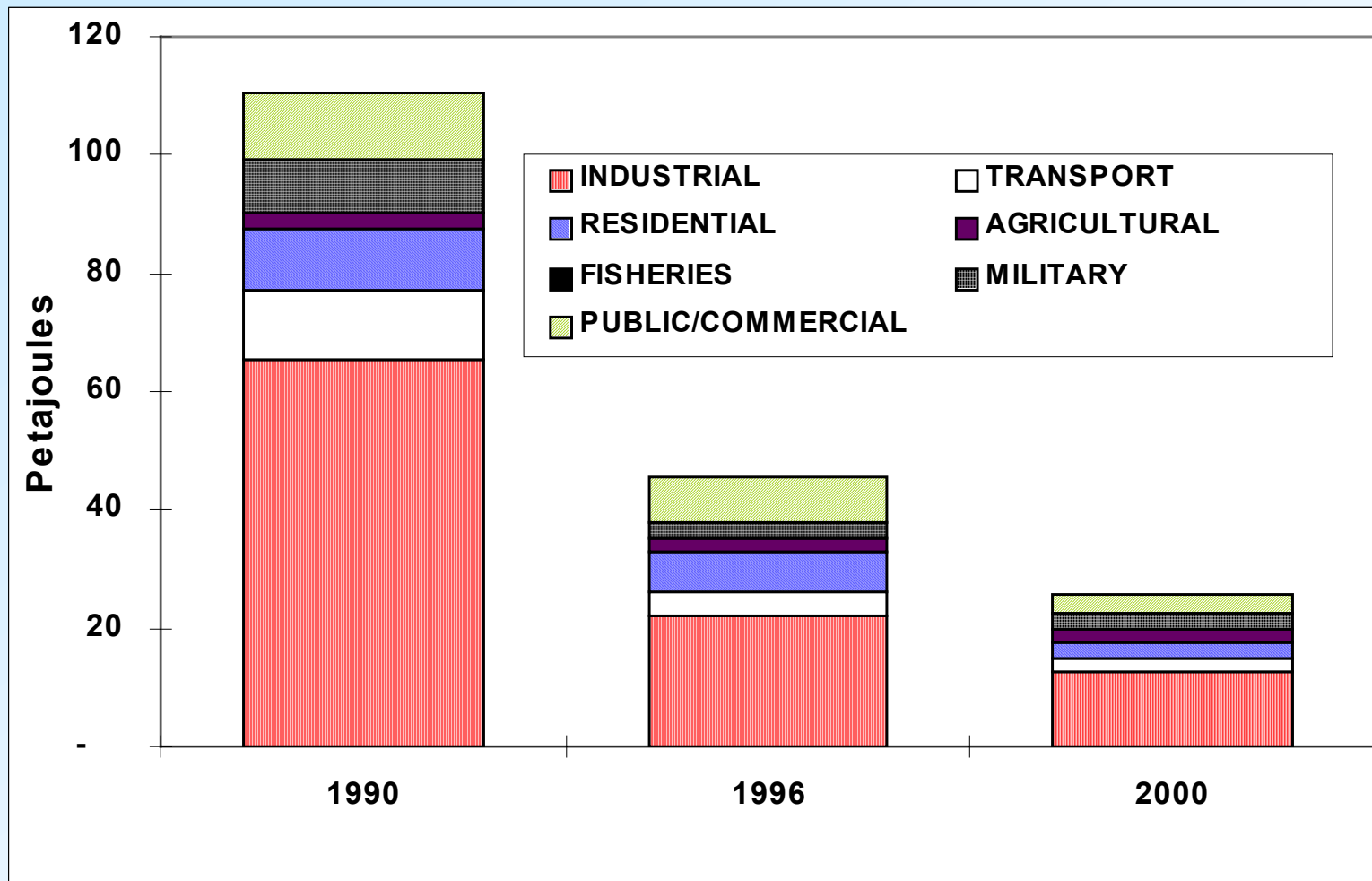


DPRK ENERGY BALANCE UPDATE: ENERGY DEMAND DATA/RESULTS

ESTIMATED DPRK FINAL ENERGY DEMAND BY FUEL, 2000



DPRK ENERGY BALANCE UPDATE: ENERGY DEMAND DATA/RESULTS



EVALUATION OF ENERGY EFFICIENCY OPTIONS FOR THE DPRK

- Estimates of impact of a small set of energy efficiency measures on electricity and coal consumption in the DPRK (2000 base year)
- Measures to Save Electricity
 - ◆ Industrial Motors and Drives
 - ◆ Motors and Drives in other Sectors
 - ◆ Residential Lighting
 - ◆ Non-residential Lighting
 - ◆ Own Use reduction in Power Plants
 - ◆ Reduction of Emergency Use in Power Plants
 - ◆ Transmission and Distribution Improvements

EVALUATION OF ENERGY EFFICIENCY OPTIONS FOR THE DPRK

□ Measures to Save Coal

- ◆ Industrial Boiler and Furnace Improvements
 - ◆ Residential and Other Sector Boiler Improvements
 - ◆ Building Envelope Improvements
 - ◆ Domestic Stove/Heater Improvements
 - ◆ Electric Utility Boiler Improvements
- Measure costs and performance based on data from application of similar measures in China and elsewhere
- Calculation of **energy, environmental** benefits

EVALUATION OF ENERGY EFFICIENCY OPTIONS FOR THE DPRK

- Efficiency options can be an inexpensive source of energy services with low environmental impact, offer other benefits
- Impacts/costs of measures to save electricity
 - ◆ Energy savings of 2.9 TWh per year for 10-20 years (the equivalent of a 400+ MW power plant)
 - ◆ Total investment of \$400 million (2000 USD) phased in over 10 years
 - ◆ **SO₂** emissions reduction: 5.5 thousand tonnes/yr
 - ◆ **NO_x** emissions reduction: 3.5 thousand tonnes/yr
 - ◆ **CO₂** emissions reduction: 0.9 million tonnes/yr

EVALUATION OF ENERGY EFFICIENCY OPTIONS FOR THE DPRK

□ Impacts/Costs of Measures to Save Coal

- ◆ Coal energy savings of 114 PJ per year for 10-20 years (the equivalent of 6 million tonnes/yr)
- ◆ Total investment of \$420 million (2000 USD)
- ◆ **SO₂** emissions reduction: 56 thousand tonnes/yr
- ◆ **NO_x** emissions reduction: 35 thousand tonnes/yr
- ◆ **CO₂** emissions reduction: 9 million tonnes/yr

- Efficiency measures also yield considerable improvements in reliability, productivity, materials use, comfort, convenience

ENERGY PATHS FOR THE DPRK

- Starting point: 1995-97 DPRK energy sector analysis and previous “Recovery”, “Decline” paths to 2005
- Subjective, illustrative update of paths taking into account DPRK changes since 1996, prospects for change
 - ◆ **NOT** based upon actual quantitative analysis of recent DPRK data (Year 2000 analysis done after the paths work described here)
- Three primary paths: “Recovery”, “Continued Decline”, and “Sustainable Development”

ENERGY PATHS FOR THE DPRK

□ “Continued Decline” Path

- ◆ No significant economic or political opening, and only modest rapprochement with the US, ROK
- ◆ Economy doesn't really decline relative to 2000, but continues stagnating
- ◆ Foreign aid and domestic policies keep economy going at a low level, but little (if any) growth in per-capita energy use
- ◆ Infrastructure maintained just enough to keep going
- ◆ No significant increase in energy efficiency

ENERGY PATHS FOR THE DPRK

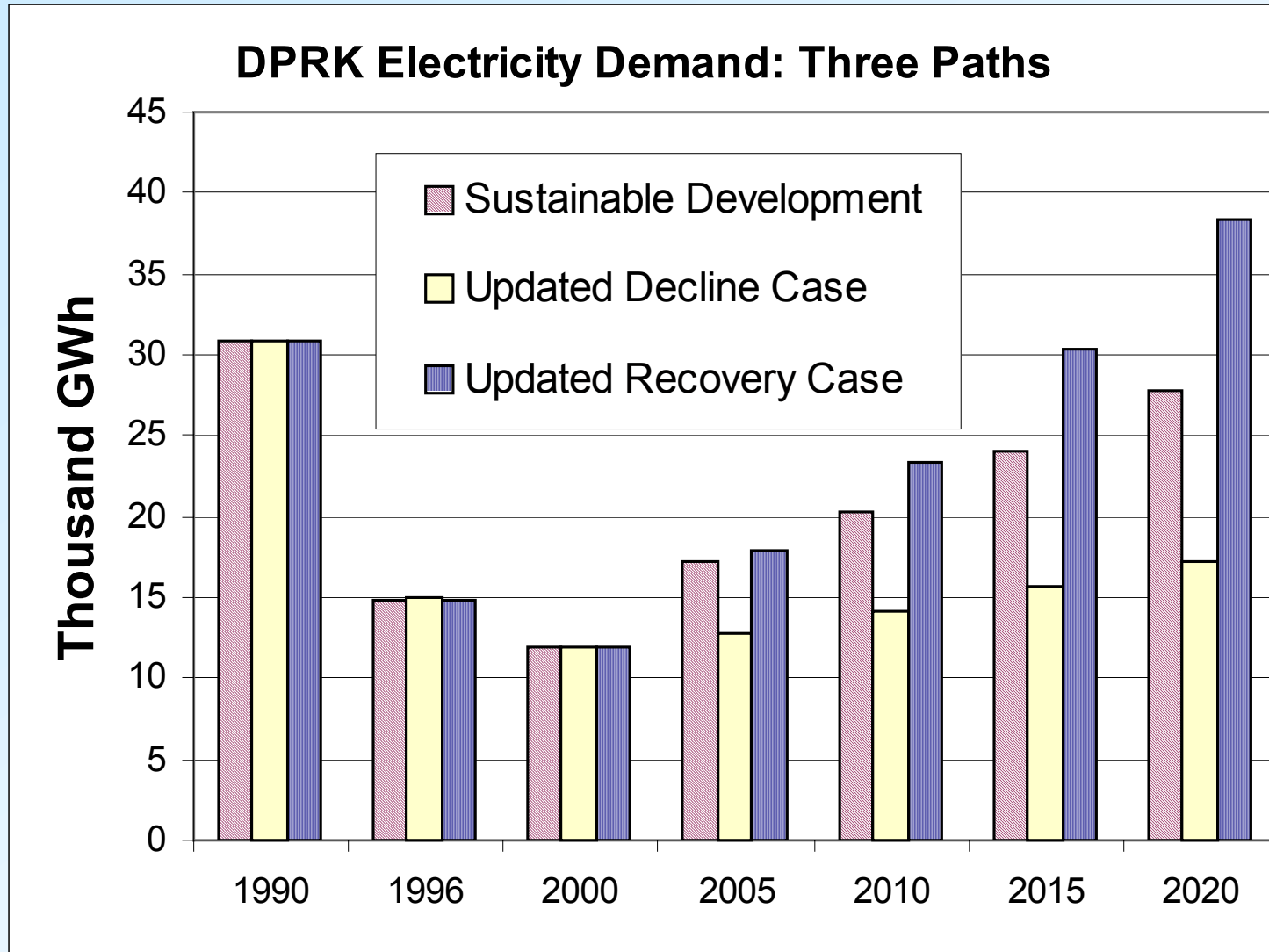
□ “Recovery” Path

- ◆ With some political, economic opening, increased foreign aid, economy starts to rebuild in ~2003
- ◆ Industrial prod., (lighter industries) increases
- ◆ Increased demand for transport, household energy use (cleaner fuels), commercial activity increase
- ◆ Refurbishment of T&D, hydro, refineries

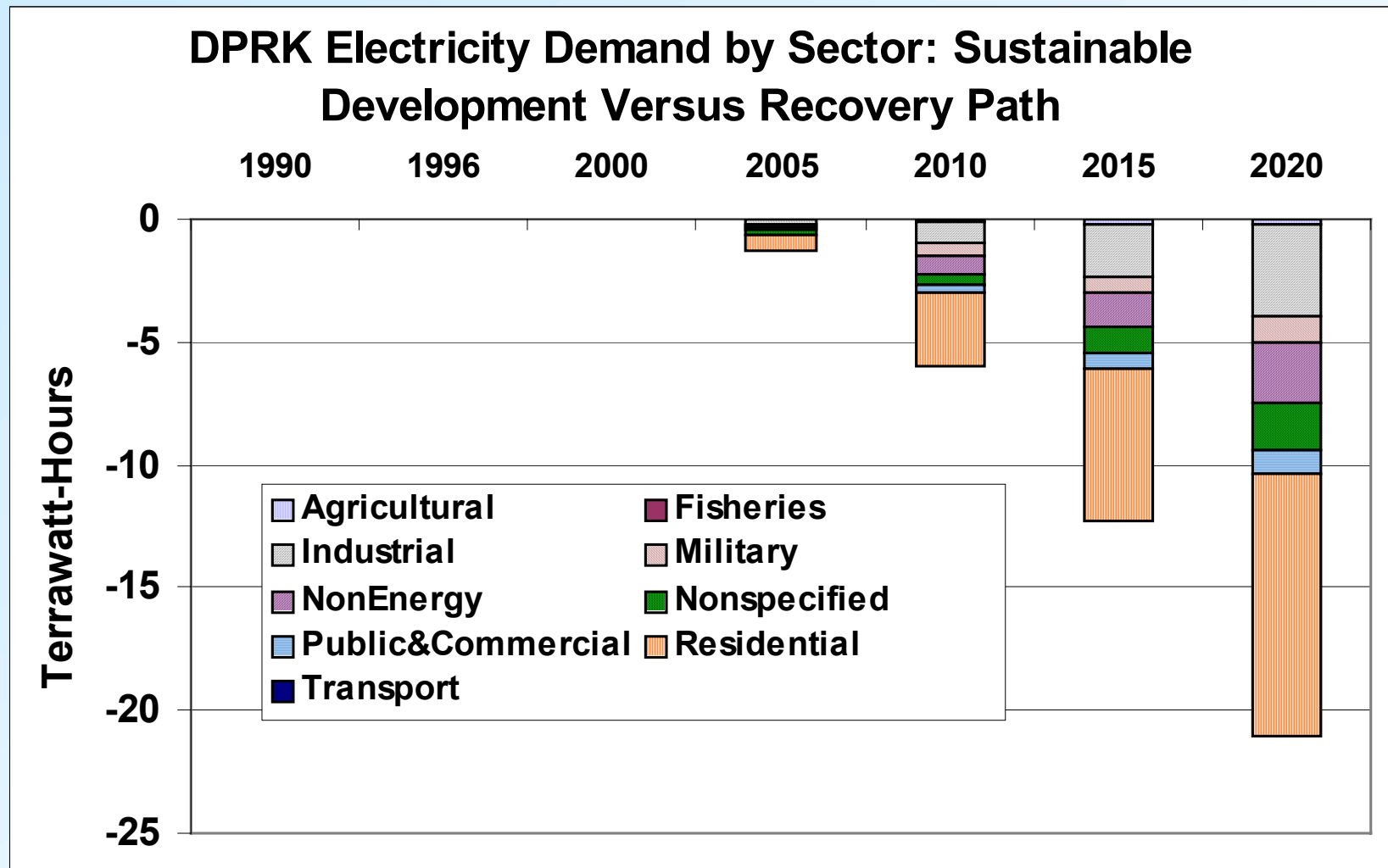
□ “Sustainable Development” Path

- ◆ Same energy services as “Recovery” path
- ◆ Aggressive implementation of energy efficiency measures
- ◆ Phase-out of older coal power, addition of LNG terminal, Gas CC, IGCC, wind, small hydro

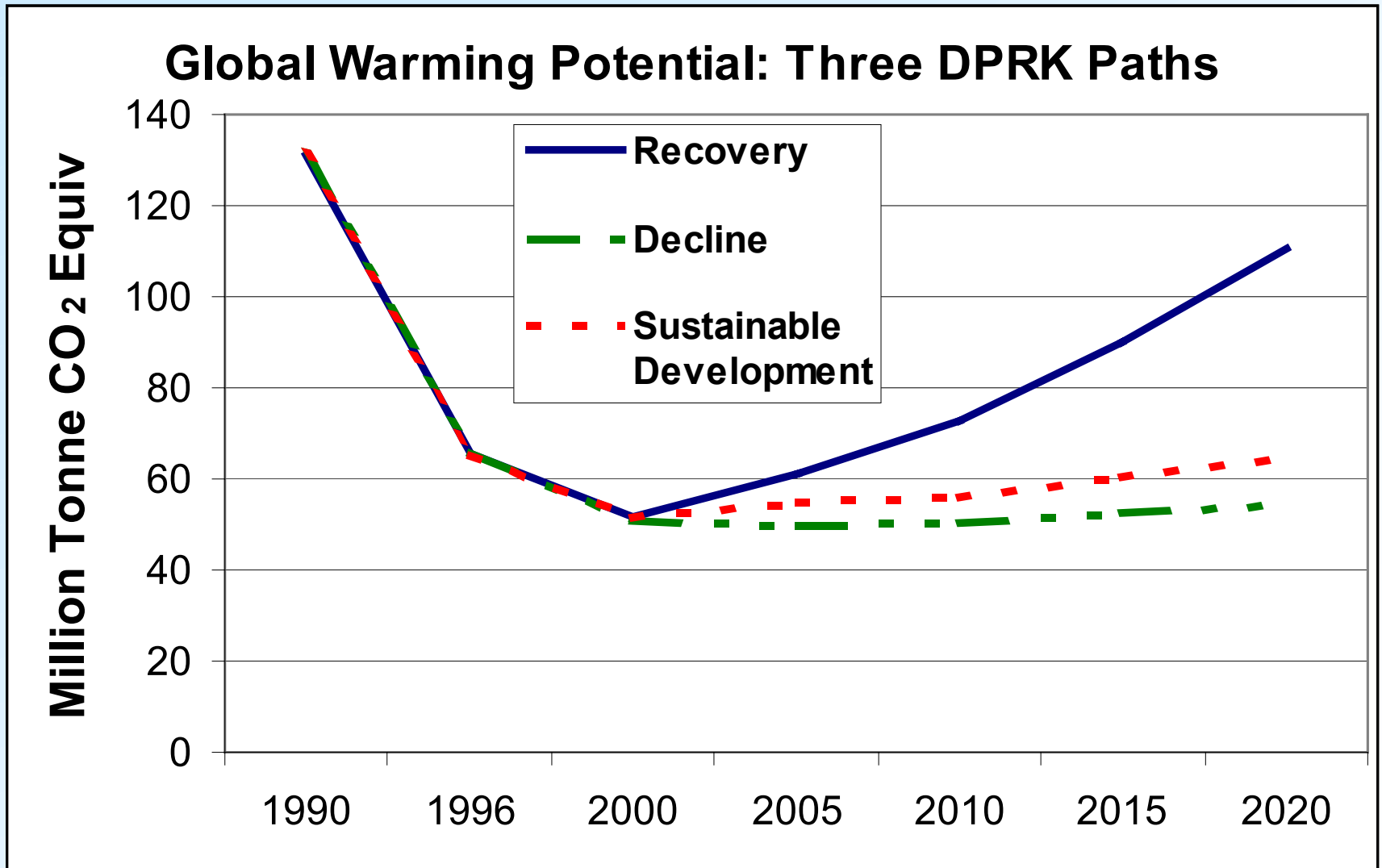
DPRK PATHS COMPARISONS



“SUSTAINABLE DEVELOPMENT” PATH RESULTS



DPRK PATHS COMPARISONS



NEXT STEPS AND POSSIBLE PATH VARIANTS

- Next Steps on DPRK Paths Analysis
 - ◆ Reconsider existing paths based on year 2000 balance, thoughts about the future
 - ◆ Add costs (demand devices, supply infrastructure, resources/imports)
 - ◆ Further estimates of environmental emissions
 - ◆ Debug data set, and iterate analysis
 - ◆ Consider other path variants
- Work with DPRK Colleagues if Possible

REGIONAL OPTIONS/OPPORTUNITIES IN AIDING DPRK ENERGY SECTOR

- Providing timely assistance in a coordinated manner will:
 - ◆ Enhance security in Northeast Asia
 - ◆ Accelerate process of DPRK rapprochement
- Nature of the DPRK's energy sector problems, mean that a focus on one or several massive projects will not work
 - ◆ Multi-pronged approach on a number of fronts is required; a large suite of coordinated, smaller, incremental projects addressing needs many areas

REGIONAL OPTIONS/OPPORTUNITIES IN AIDING DPRK ENERGY SECTOR

- Collaboration on regional energy sharing proposals involving DPRK (large projects, with longer time lines, approached incrementally)
 - ◆ Electricity grid interconnections
 - ◆ Transport interconnections
 - ◆ Gas pipelines
- Involve DPRK colleagues in feasibility studies
 - ◆ Provide training to allow full participation
 - ◆ Develop regional working groups with clear targets, data, results sharing
 - ◆ Work on several fronts--Technical, economic, environmental, institutional

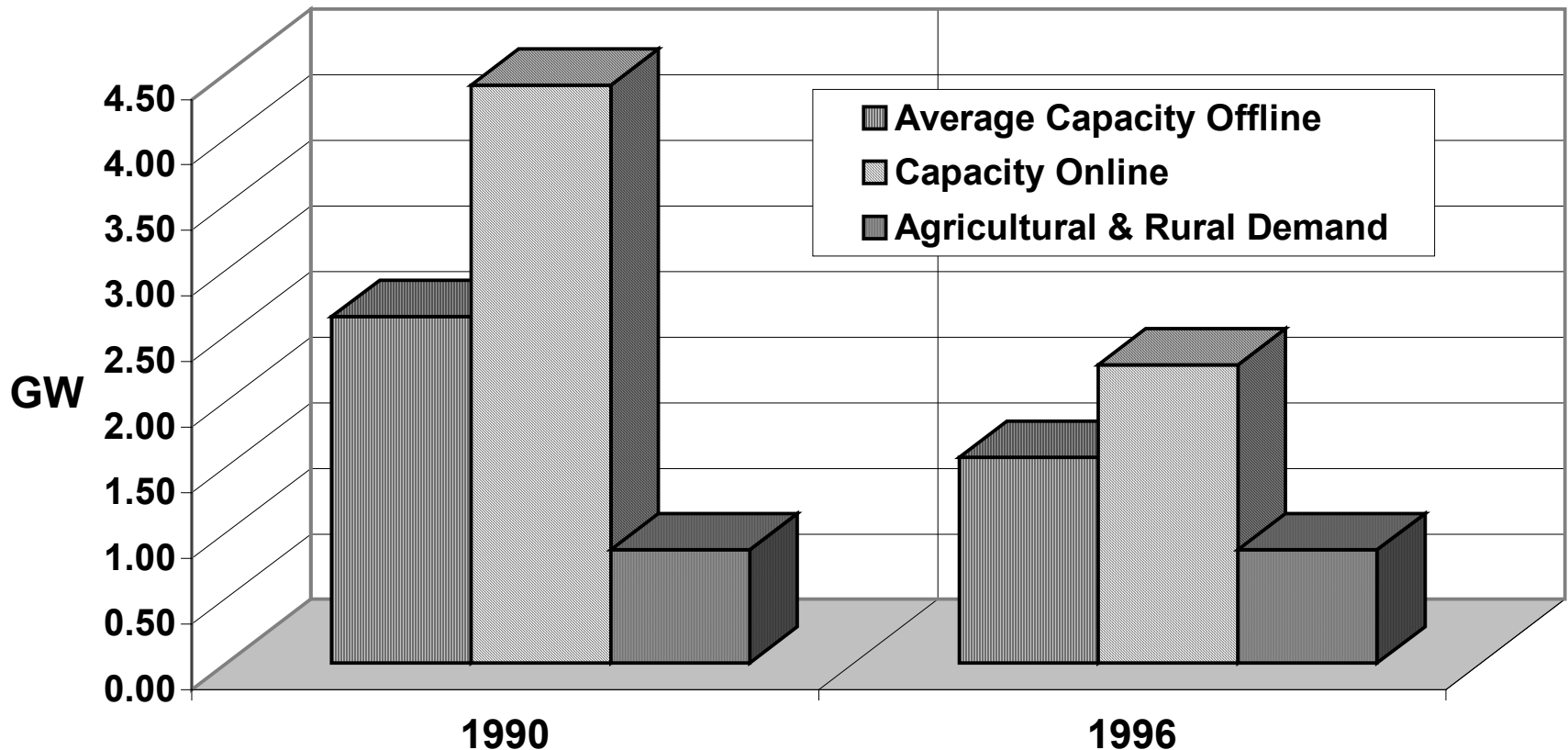
REGIONAL OPTIONS/OPPORTUNITIES IN AIDING DPRK ENERGY SECTOR

- Encourage regional working groups and/or regional assistance to the DPRK in “small project” areas of energy sector assistance:
 - ◆ Assist with development of alternative sources of small-scale energy--small/mini-hydro, wind, solar thermal and photovoltaic
 - ◆ Implementation of Energy-efficiency Measures
 - ◆ Local manufacturing/joint ventures producing goods needed in DPRK **and** abroad (export earnings potential)
- Smaller-scale activities where colleagues work directly with North Koreans are most effective

APPLICATION (WITH SURVEY DATA) FOR RURAL NEEDS ANALYSIS

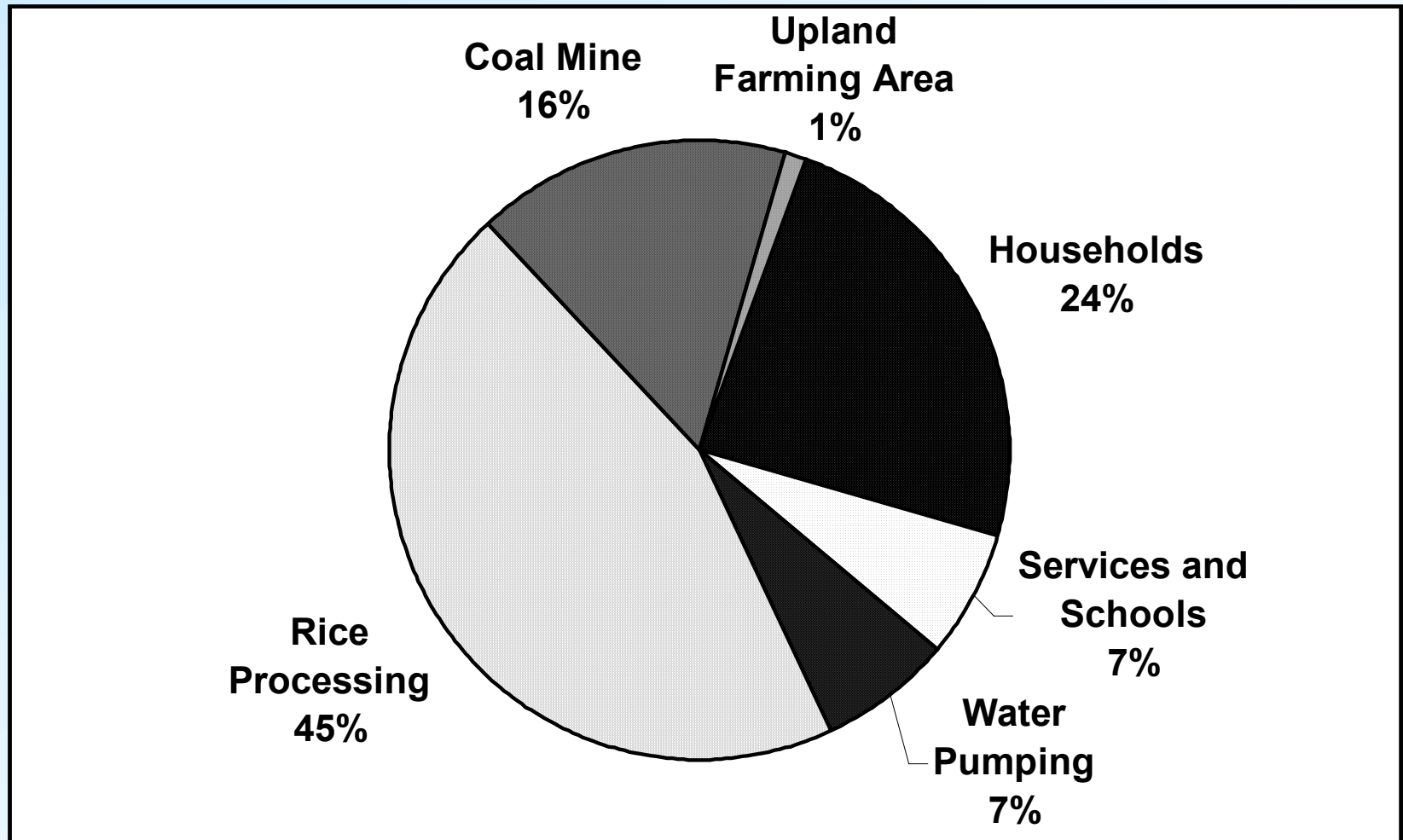
- Use of “Bottom-up” approach on national level..

ESTIMATED DPRK ELECTRICAL GENERATING CAPACITY



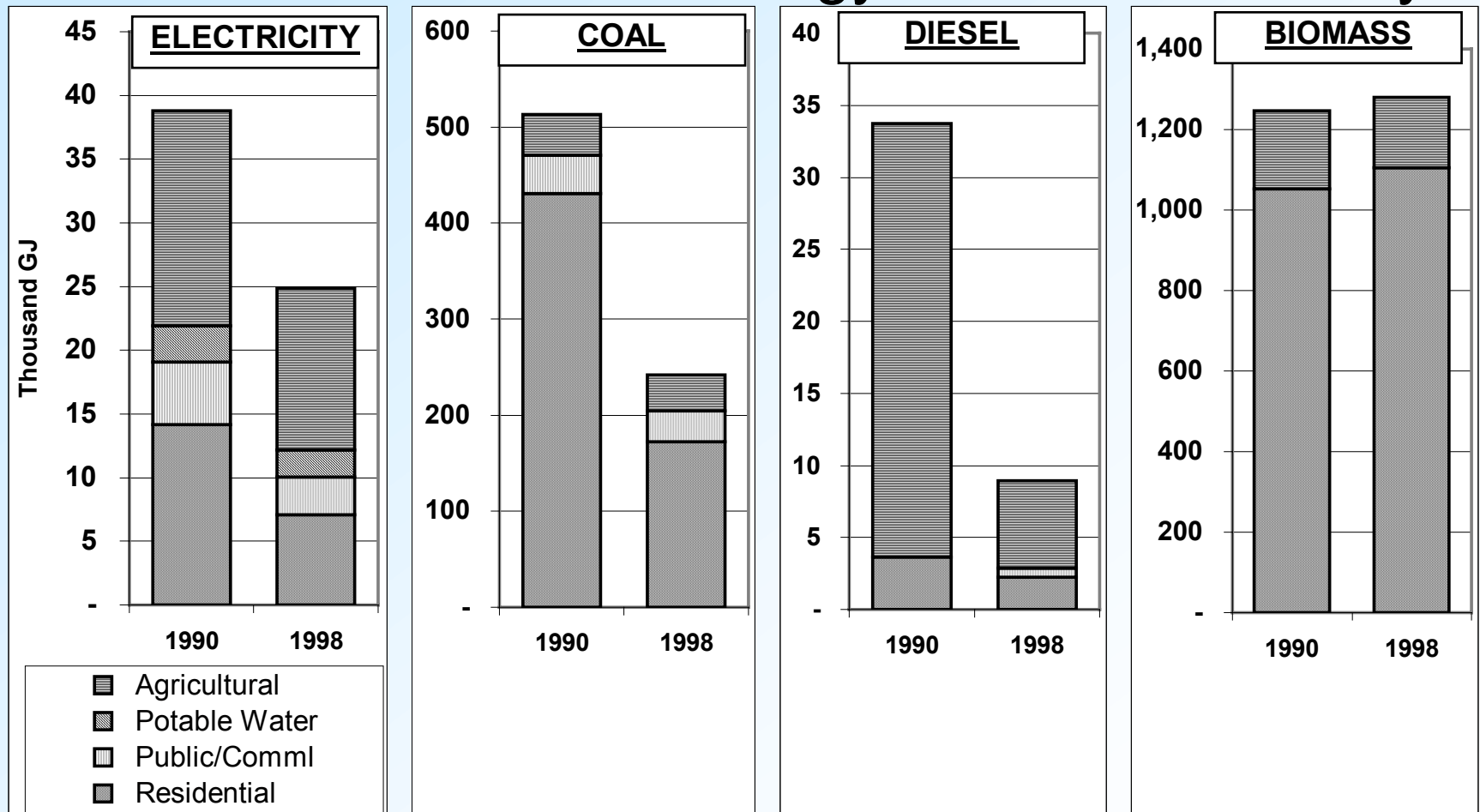
APPLICATION (WITH SURVEY DATA) FOR RURAL NEEDS ANALYSIS

- Combined with Survey data..



APPLICATION (WITH SURVEY DATA) FOR RURAL NEEDS ANALYSIS

□ Was used to evaluate energy needs for a county..



APPLICATION (WITH SURVEY DATA) FOR RURAL NEEDS ANALYSIS

□ And to semi-quantitatively estimate needs

- ◆ Assistance with designing, implementing mini/ micro hydro and wind power (significant local potential in county), including T&D improvements
- ◆ Assistance with energy efficiency improvements, particularly motors, piping, other infrastructure for pumping, agric. processing
- ◆ Supplies of fertilizer, tractor fuel, parts
- ◆ Assistance with refurbishing energy-using and electricity supply infrastructure in mines
- ◆ Assistance with supply of cooking fuels (LPG?), efficient residential lights and appliances