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”DPRK Energy Sector Assistance Options and Sequencing Considerations for the International Community”

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Contents

- Introduction: The DPRK Energy Sector as a Key to "Denuclearization", and Challenges in Providing Energy Sector Assistance
- Overarching Energy Sector Needs and Options
- Phasing of Assistance to DPRK Energy Sector—Short-, Medium- and Long-term
  - "LWR-Equivalent" Concept
- Goals and Considerations in Developing Energy Assistance Options
- Energy Assistance Lessons from Analysis of Potential DPRK "Collapse" Pathways
- Conclusions

Introduction: DPRK Energy Sector as a Key to "Denuclearization"

- **Energy sector needs and requirements for energy security are critical dimension of North Korean nuclear weapons challenge**
  - **DPRK difficulties in obtaining energy supplies and maintaining aging energy supply system have been a driver of its nuclear weapons policies**
  - **Addressing energy sector needs plays a key role in working toward a solution of the DPRK nuclear weapons dilemma**
  - **When 6-Party Talks resume, resolving the DPRK's energy sector problems and improving DPRK energy security will be key components of transformation of the DPRK economy to one that is peaceful, self-sustaining**

Introduction: DPRK Energy Sector as a Key to "Denuclearization"

- **The effective denuclearization of North Korea will require provision of energy assistance by the international community**
  - **Phased package that is carefully coordinated with milestones in the denuclearization process**
  - **Options offered must be based on a realistic assessment of the needs and capabilities of the DPRK—including economic and humanitarian conditions as well as political priorities**
  - **To understand the DPRK's energy needs and capacity to use energy sector assistance of different types, need to understand the DPRK's energy situation and its impacts on its broader economy and society**

Introduction: Challenges in Providing the DPRK with Energy Assistance

- Measures designed to improve the DPRK's energy sector face an array of challenges that must be fully appreciated and reflected in assistance plans
  - Problems with the DPRK economy's physical infrastructure, and most notably its energy infrastructure
  - Infrastructure problems mean the DPRK will not be able to redevelop its energy system/economy without outside help
  - Suppressed and latent demand for energy services in the DPRK economy mean that a surge of demand will occur when supply constraints are removed (which will, for example, make badly needed energy efficiency investments look less effective)
  - The DPRK substantially lacks markets for energy products, providing few incentives for energy users to control consumption, no guarantee that fuel suppliers will recover cover costs of production/reinvestment

Introduction: Challenges in Providing the DPRK with Energy Assistance

- Additional challenges to be appreciated and reflected in assistance plans:
  - A lack of human capacity in many fields: need to build on usually strong general education, excellent work ethic with capacity building in advanced science and engineering, economics and finance, regulation, policy development
  - An institutional lack of capacity to usefully absorb aid, including energy aid, due to current DPRK structure for counterpart agencies working on foreign assistance projects, compartmentalization of the DPRK's dealings with foreigners, culture of commonplace graft and patronage, means near-term aid in the form of very large projects will result in inefficient use of resources, or failure
  - Our advice: focus, especially in the first years of energy sector assistance, on small, fast, cheap, and local energy projects with significant demonstration value

Overarching Energy Sector Needs and Options

- **Assistance for internal policy and legal reforms to stimulate and sustain energy sector rebuilding**
  - **Capacity-building for reform of energy pricing practices, energy planning, training for energy sector actors, regulatory agencies, educational/research institutions**
- **Rebuilding of electricity transmission and distribution (T&D) system**
  - **Start by working collaboratively to define priorities, and with pilot installations in limited areas (associated with economic investments)**
- **Rehabilitation of power plants and other coal-using infrastructure**
  - **Small and medium boilers, power plants, steam lines**
- **Rehabilitation of coal supply and coal transport systems**
  - **Required for short- and medium-term economic improvement**
- **Development of alternative sources of small-scale energy and implementation of energy-efficiency measures**
  - **Emphasis on fast, small and cheap, agricultural and humanitarian applications, support for economic development in specific areas. Energy efficiency is key to expanding availability of energy services**
- **Rehabilitation of rural infrastructure to improve agricultural production**
- **Begin transition to gas use with Liquid Petroleum Gas (LPG) networks**
  - **Clean burning, limited military diversion potential, modest investment costs**

Phasing of Assistance Approaches: Short-term Options

- Provision of fuels for power generation, district heating, possibly to mineral-export-oriented industrial plants (HFO and coal)
- Provision of diesel engine-generator sets, agricultural equipment
  - Electric power, heat, agricultural end-uses with humanitarian emphasis
- Initial efforts at building human capacity
  - Study tours on topics including energy efficiency, renewable energy, power systems design, energy markets
  - Training by foreign experts in the DPRK
  - DPRK students in existing University-based "short courses" abroad

Phasing of Assistance Approaches: Medium-term Options (1)

- **Refurbishing of selected major energy facilities—demonstration/pilot projects**
  - **Thermal power plants/district heating plants: replacing/repairing boilers, steam systems; installing control and monitoring systems**
  - **Larger hydro power plants: dam repair/dredging, replacing/repairing turbines and generators**
  - **Coal supply infrastructure in one or more key mines: technical advice refurbishment, equipment provision, coal transport infrastructure**
- **Integrated energy supply/grid refurbishment with economic development assistance**
  - **Mini-hydro and/or biomass-fired plants for new/rebuilt "mini-grids", modest-sized coastal LPG terminals, gas-fired power**
  - **Co-development of local (county-sized?) export-oriented (non-weapons) factory or mine complex**

Phasing of Assistance Approaches: Medium-term Options (2)

- **Additional capacity-building and related pilot/demonstration projects**
  - **Broadened scope, enterprise-level training, training within DPRK universities and at universities around the world**
  - **Variety of topics/pilot projects possible: energy markets, energy planning, energy systems, environmental regulation, energy efficiency/renewable energy coupled with health care, education, sewage/water treatment, international experts guiding with hands-on work by DPRK technicians.**
  - **Develop "centers of excellence"—new or within existing DPRK institutions**
- **Reforestation of degraded areas**
  - **Will need to be coupled with provision of fuel supplies for local cooking and heating enduses to (help) assure that reforested areas grow mature trees**
  - **Training opportunities in monitoring of reforested areas**

Phasing of Assistance Approaches: Longer-term Options (1)

- **Completion of one or both of the Sinpo/Kumho light water nuclear reactors**
  - **Unappealing to many, but important issue of national pride to the DPRK, may be attractive to ROK**
  - **Couple with training in adherence to IAEA protocols and non-proliferation measures**
- **Larger national/international infrastructure projects**
  - **Smaller LNG receiving facility, shared with ROK, with smaller gas combined-cycle electricity or heat-and-power plant to continue process toward adopting gas use**
  - **More extensive national electrical grid reconstruction, including installation of modern control/communications equipment, meters, substations, control/modeling software**
  - **Assistance with building natural gas grids (and marketing/ metering systems) together with regional gas trade initiatives**
  - **More extensive assistance with coal supply infrastructure, including related transportation infrastructure (rail)**

Phasing of Assistance Approaches: Longer-term Options (2)

- Continued training, tech transfer, other multi-faceted assistance in energy efficiency/renewable energy
  - Possible mechanisms: Major degree programs at North Korean Universities, facilitating (loan guarantees?) investment by outside companies for NK production of solar hot water heaters, solar PV panels, wind power, insulation materials, high-performance windows, other devices with markets inside the DPRK and beyond
- Think about offering LWR-equivalent "packages" offering same net "value" to the DPRK
  - For example: 600 MWe hydroelectric plant rehab + 700 MWe thermal plant rehab + 50 MWe local wind power with pumped-storage hydro and diesels + $500 million investment in energy efficiency + 40 MW diesels for humanitarian applications + one small LPG terminal, associated T&D infrastructure ~ equal in value to one LWR unit, offers much more energy/energy savings that DPRK gets to "keep"

LWR-Equivalent Concept

- Assemble an illustrative "package" of energy assistance measures that has the same monetary value, on a net present value basis, as the 2000 MWe of Light Water Reactor (LWR) capacity included in the original Agreed Framework
  - Note that this is a 2-LWR-Unit package, larger and somewhat different in composition from the 1-unit package described previously in this presentation
- Estimate the energy benefits of the package, and compare with those of the LWRs
- Units: "GWh equivalent"—counts non-electric fuels/savings based on electricity it would provide if input to fossil-fueled electricity generation

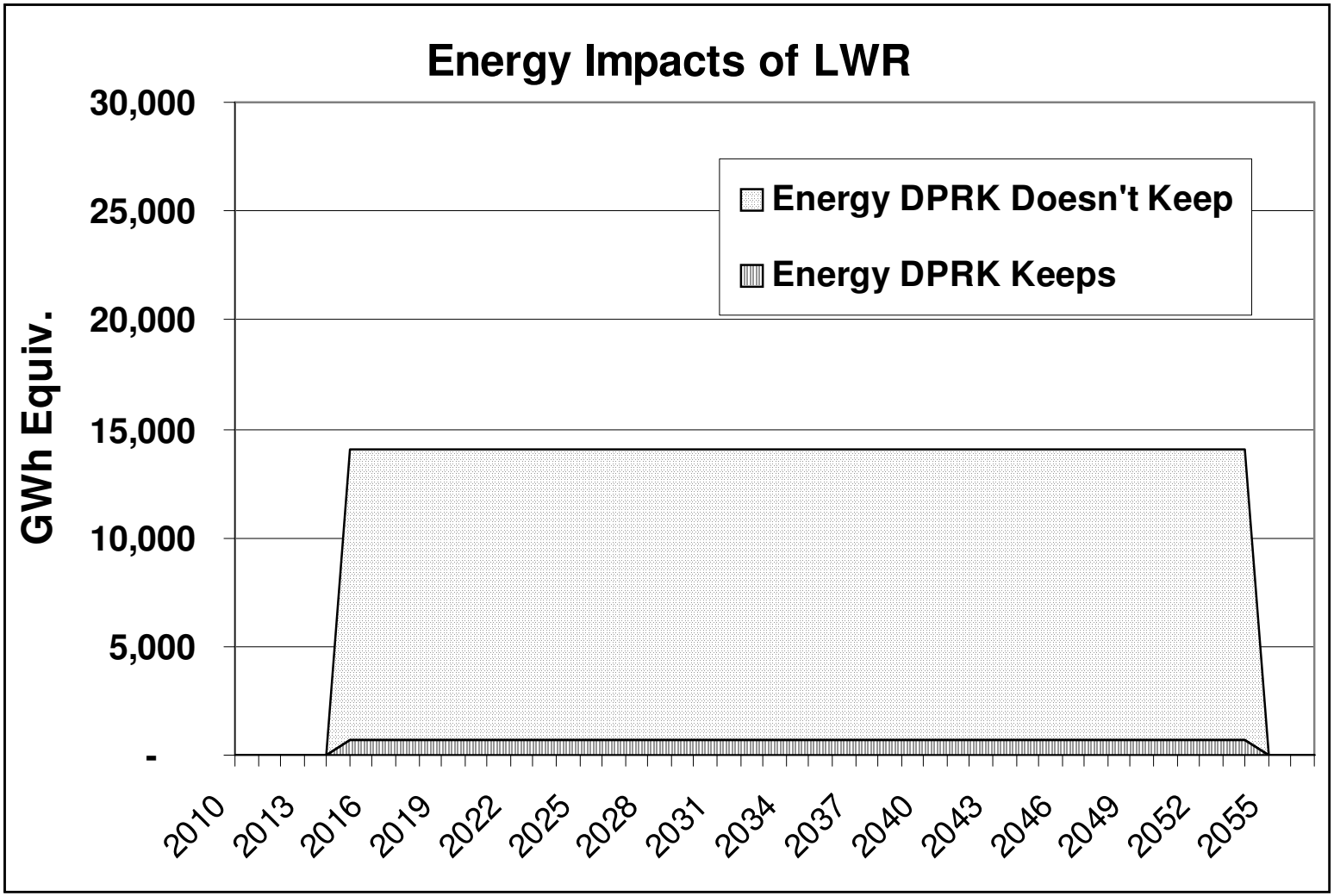
LWR-Equivalent Concept: ASSUMPTIONS REGARDING LWRS:

- 2000 MWe capacity, 80% capacity factor
- Capital cost of $2500/kW, repaid at 2%/yr over 40-year plant life
- 95% of output of plant sold to ROK (which pays for transmission line) at $60/MWh
- DPRK pays fuel, O&M costs
- 15%/yr nominal discount rate (that is, assumes strong DPRK preference for near-term payments)
- Calculated net present value (2010 USD), **$1.26 billion**

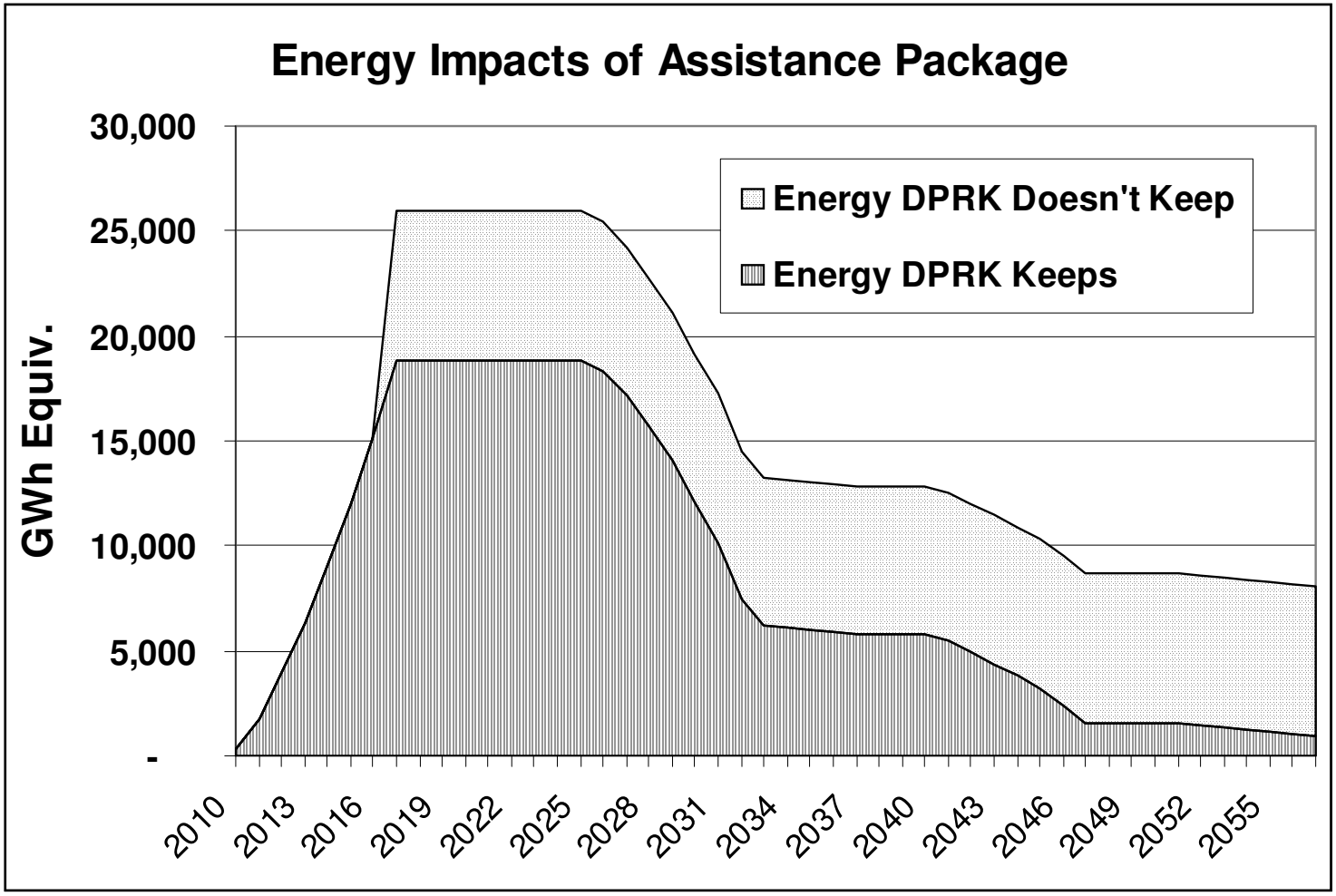
LWR-Equivalent Concept: ENERGY ASSISTANCE PACKAGE ASSUMPTIONS

- All options phased in over 7 years
  - Hydro rehab: 1200 MWe net added capacity over 7 years
  - Thermal plant rehab: 1400 MWe addressed, providing major efficiency improvements, net power increase; DPRK provides additional coal required
  - 105 MW local wind power with pumped-storage hydro, and diesels for grid support; DPRK pays for diesel after year 7
  - ~$1 billion (undiscounted) investment in energy efficiency to save electricity, heat, coal (and likely biomass)
  - 84 MW diesels for humanitarian applications ; DPRK pays for diesel after year 7
  - One small LPG terminal and associated T&D infrastructure per year for 6 years; DPRK pays for LPG after year 7
  - Small-ish LNG facility completed in year 7, paid for by ROK, which gets 90% of gas. DPRK keeps 10% as rent, receives T&D and related infrastructure, plus 100 MWe gas CC
- Calculated net present value (2010 USD), $1.26 billion

LWR-Equivalent Concept: LWR ENERGY BENEFITS



LWR-Equivalent Concept: ASSISTANCE PACKAGE ENERGY BENEFITS



LWR-Equivalent Concept: Tradeoffs Between LWR and "Package" Options

- Most of Energy Assistance Package energy benefits stay in DPRK; nearly all of LWR output doesn't
- Most of Energy Assistance Package value (infrastructure/assistance provided) is in first few years; LWR value (sales proceeds) accrue over 40 years
- LWR value (sales proceeds) is in cash; Energy Assistance Package value is in goods
- *Note: Assistance Package shown is an illustration, not a proposal; infinite different combinations of measures are possible*

Considerations in Choosing Energy Assistance Options (1)

- **How Do Options Considered Affect DPRK Economy and Society?**
  - **Help to fulfill basic human needs; contribute significantly toward meeting energy needs; build human capacity and economic opportunities; bring about engagement of DPRK citizens with those of other nations; offer environmental benefits; increase energy security/sustainability; be visible to North Koreans**
- **What Does the DPRK Want?**
  - **Difference between preferences stated in official vs. unofficial settings**
  - **Difference in preferences by different DPRK actors with different degrees of influence over negotiations**
- **What Happens if Negotiations Don't Go as Intended?**
- **What Happens if the DPRK Collapses?**
  - **Will the assistance measures implemented to that point help with "picking up the pieces"?**

Considerations in Choosing Energy Assistance Options (2)

- How Much Aid Can the DPRK Absorb?
  - Exceeding constraints—infrastructural, technical, human, organizations—will leads to wastage, graft, disappointment
  - Absorption capacity can be developed over time
- Relationship to Regional Energy Systems
  - Addressing DPRK problems in the context of regional problems aids effectiveness, persistence
  - Steps toward regional integration and co-dependence reinforce changes in DPRK
- What Options are Likely to Be Beneficial, and Which Problematic, from an ROK Perspective?
- Who Pays, and How Much?
  - Sources of funding, and DPRK perspectives on value acceptable in trade for forgone nuclear threat
- Benefits to Countries of Contributing to Energy Sector Aid Packages for the DPRK

Energy Assistance Lessons from Analysis of Potential DPRK "Collapse" Pathways

APPROACH

- Define several significantly different, illustrative regime collapse pathways (out of universe of many) **THOUGH WE THINK IS COLLAPSE IS UNLIKELY AND TO BE AVOIDED**
- Think about impacts of collapse on the DPRK energy sector, energy and related infrastructure
- Think about how the ROK, US, and the rest of the global community might/would need to respond to energy needs following different types of collapse
- Identify "robust" planning approaches that, if pursued now/soon, would prove useful in the event of any type of collapse pathway

Energy Assistance Lessons from Analysis of Potential DPRK "Collapse" Pathways

- Do **capacity building** on lots of topics whenever possible; it's cheap, useful/necessary in any path, and has many ancillary benefits
- Plan now for the **rebuilding of the T&D system**. Will be necessary sooner or later. Maybe stockpile key components such as transformers and substation switchgear for rapid installation as needed
- Assess the ROK's **current refining capacity** versus the petroleum products needs of reunified (in fact if not in deed) Korea. Start talking with Russians about possibility of **rebuilding/expanding Sonbong refinery** so as to be ready to jump into project when conditions permit

Energy Assistance Lessons from Analysis of Potential DPRK "Collapse" Pathways

- Have the discipline to plan to provide **high-efficiency energy demand (and supply) devices** when rebuilding the DPRK economy so as to reduce the burden on energy supply infrastructure
- Think through how **markets** for energy goods can be established so as to spur private sector investments
- Plan **integrated energy infrastructure/economic development demonstration projects**, for example, on a county scale, and try to get some implemented even before collapse
- Network with other interested parties to provide the best **assessment** possible of DPRK energy sector status, and needs, and collaborate on concrete **plans** to address those needs when an opening occurs

Conclusions (1)

- Developing energy options for the DPRK requires consideration from many points of view to avoid unintended consequences
- The DPRK will insist that provision of LWRs be on the table, so other parties should be prepared to discuss
  - Think about providing one LWR unit with a broad package of other options of similar perceived value
- Options that involve energy efficiency and renewable energy initiatives are generally "robust" for DPRK application, fulfilling many different considerations, even in "collapse"
  - Will require large-scale organization, engagement, coordination and patience

Conclusions (2)

- Larger-scale, longer-term options contributing to regional energy infrastructure and economic integration may have significant benefits to the DPRK and partner countries
  - But need to set up by with smaller, faster, local projects, extensive human capacity-building
- Capacity-building will be a key element of assistance under any conditions
- Continued Information gathering/analysis essential for planning of useful assistance activities
- Helping DPRK toward sustainable solutions to its long-term energy problems is necessary, though not sufficient, condition for enduring success in "denuclearization"

Nautilus Engagement Activities with DPRK Delegations

- **DPRK Study Tour Missions to US**
- **Unhari Village Humanitarian Wind Energy Project**
- **Building Energy Efficiency Project (2008-201?)**

American and Korean Engineers Working Atop Windmill Tower

Training Should be Done at Every Step, Every Level: Wind Turbine Power-house Training

Installing "Ground Rods" at Unhari with DPRK Engineer

DPRK Building Energy Efficiency Training Project

von Hippel/Hayes
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THANK YOU!