



O&M Budgeting

AWEA, Asset Management

Jan. 17/18, 2008 - San Diego

Uwe Roeper, Pres. ORTECH

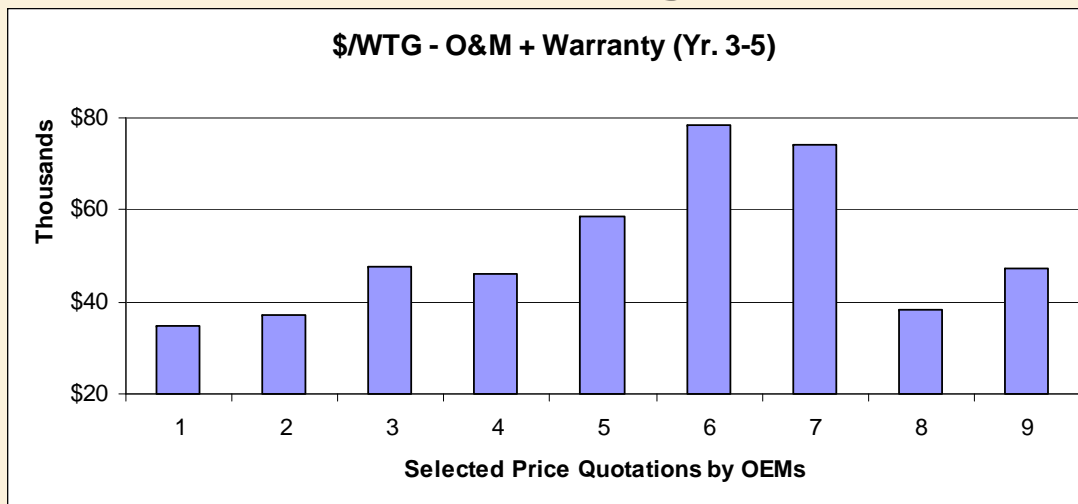
ORTECH Power

- **Consulting, including:**
 - **O&M plans, forecasts, budgets**
 - **Op. performance reviews**
 - **Field services**
 - **Pet interest: long term repair costs for WTGs (5 years now).**

Budgeting Challenge

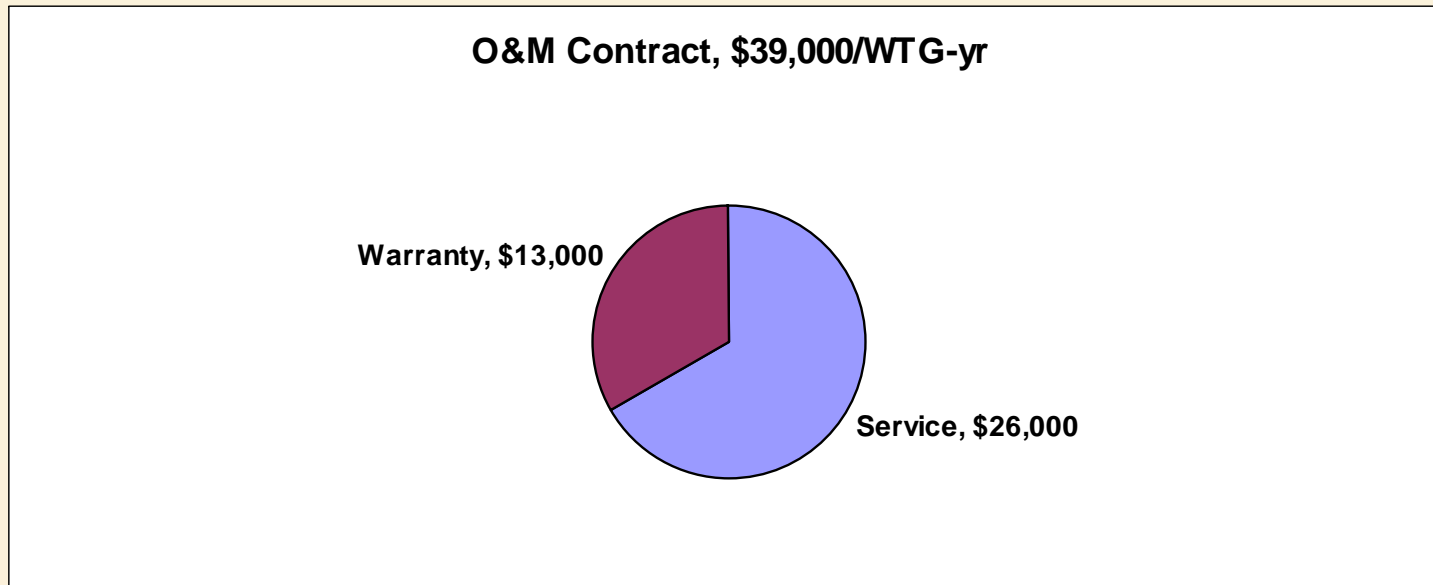
- **Turbine design life 20 years, op. experience < 10 years.**
- **Owners & manufacturers hesitant to share experience data.**
- **Few government statistics (except ISET in Europe; Sandia & NERC starting).**
- **O&M costs are site specific and model specific.**

Cost of Warranty, Service Maintenance Contracts



- **Example of price variability in WMS contracts.**
- **High quotes related to remote sites.**
- **Large WTGs typically have slightly higher \$/WTG-yr.**
- **We will use \$39,000/WTG-yr as typical for 1.5 MW turbine (limited ext. wty. + srvc.)**

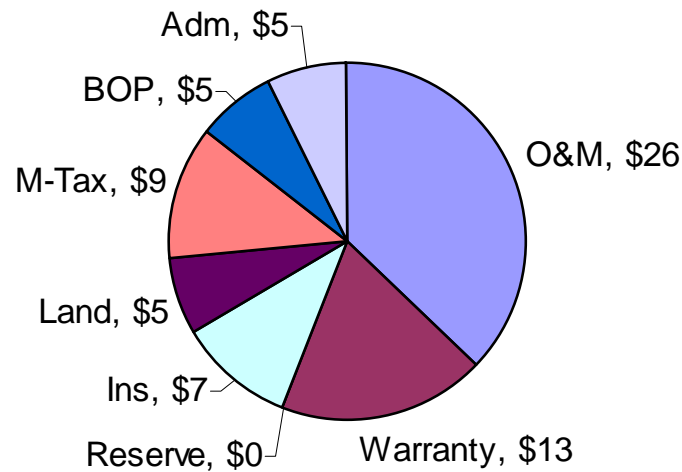
Wty. portion of WMS



- **Warranty cost often not broken out.**
- **Contractual exclusion vary.**
- **1/3 assumed as wty. portion of contracts.**

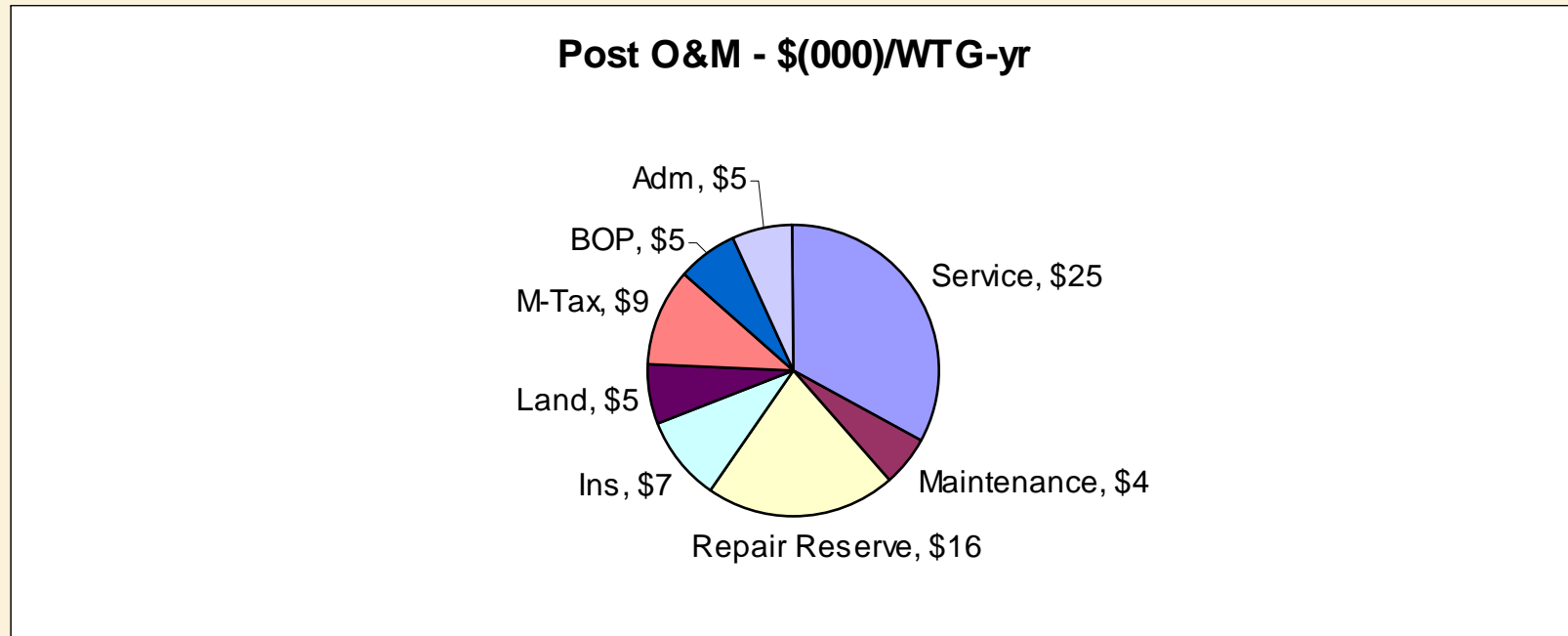
WMS as part of total O&M

Warranty O&M - \$(000)/WTG-yr



- **WMS typically amounts to approx. 60%**
- **Largely market based, not indicative of actual.**
- **Avail. only for early years (few repairs).**

Post wty. service costs



- **Service portion of WMS upper budget limit**
 - 24/7 remote monitoring + scheduled mtnc. + basic on-site.
- **Budget varies by turbine model and site location.**

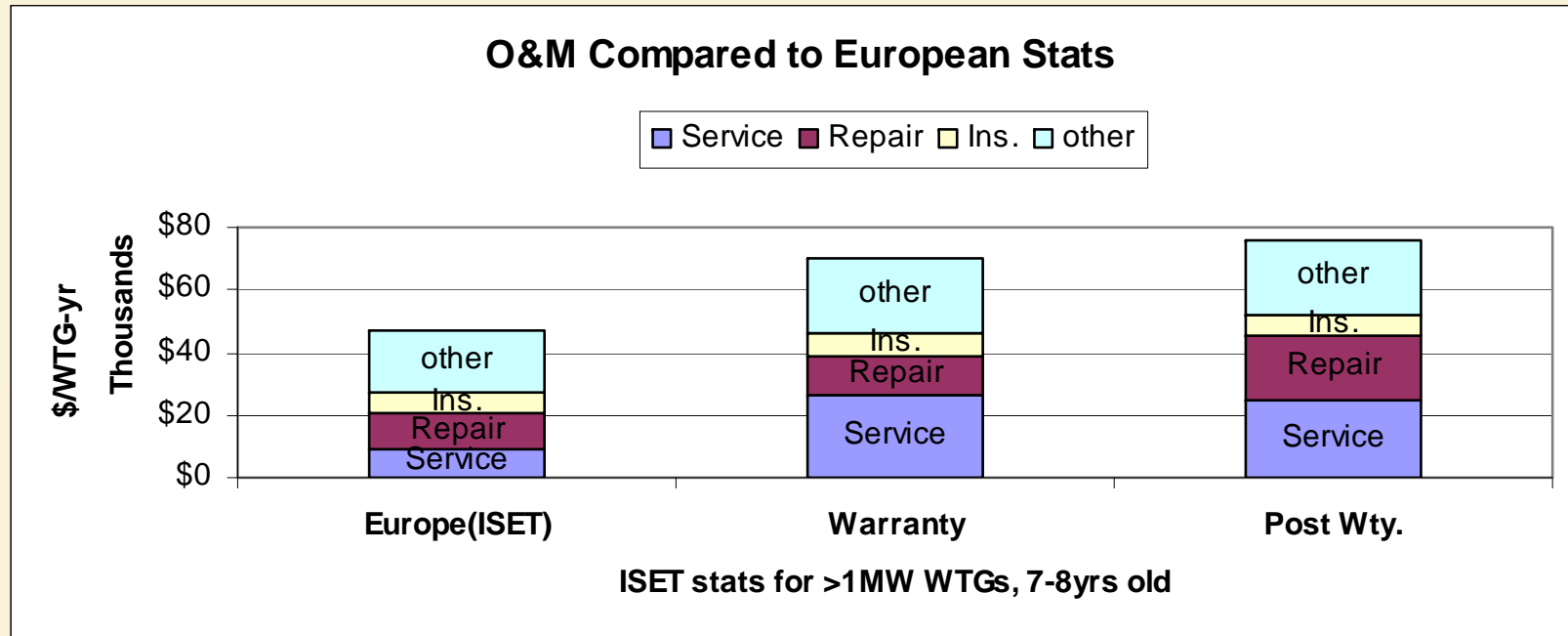
Service: 3 key functions

- **24/7 Remote monitoring**
- **Scheduled maintenance**
- **On-site services**

Service provider options:

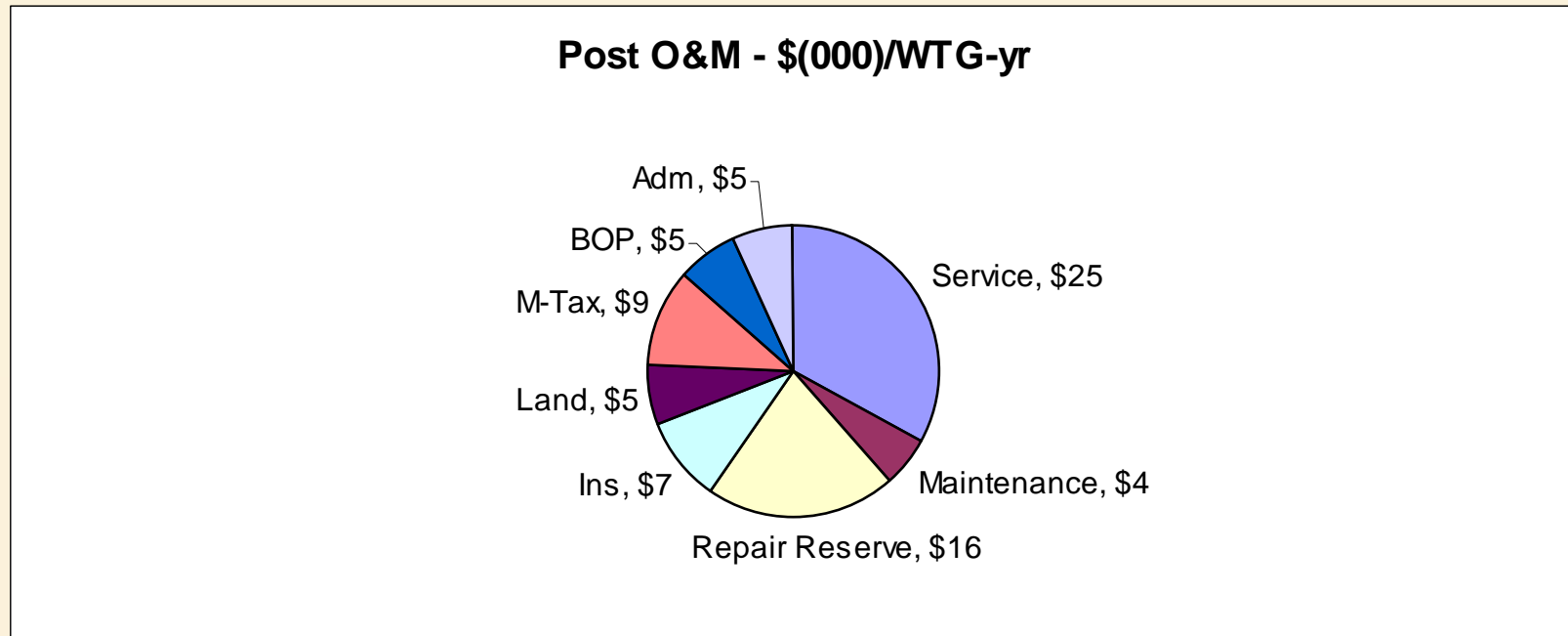
- **OEM**
 - **Pro:** familiar, meets specs, experienced, has parts.
 - **Con:** perhaps not least cost.
- **Independent Providers**
 - **Pro:** perhaps reduced cost, no training required.
 - **Con:** involves procurement process, performance contract set-up, change in process, parts.
- **Internalize**
 - **Pro:** potential for least cost.
 - **Con:** need to develop competence (training, SOPs, mgmt. system), parts.

Service Cost Check



- **Comparison to Europe (ISET) data suggests significantly lower service costs may be achievable.**
- **Is a reduction from \$26,000/WTG to \$9,000 possible?**

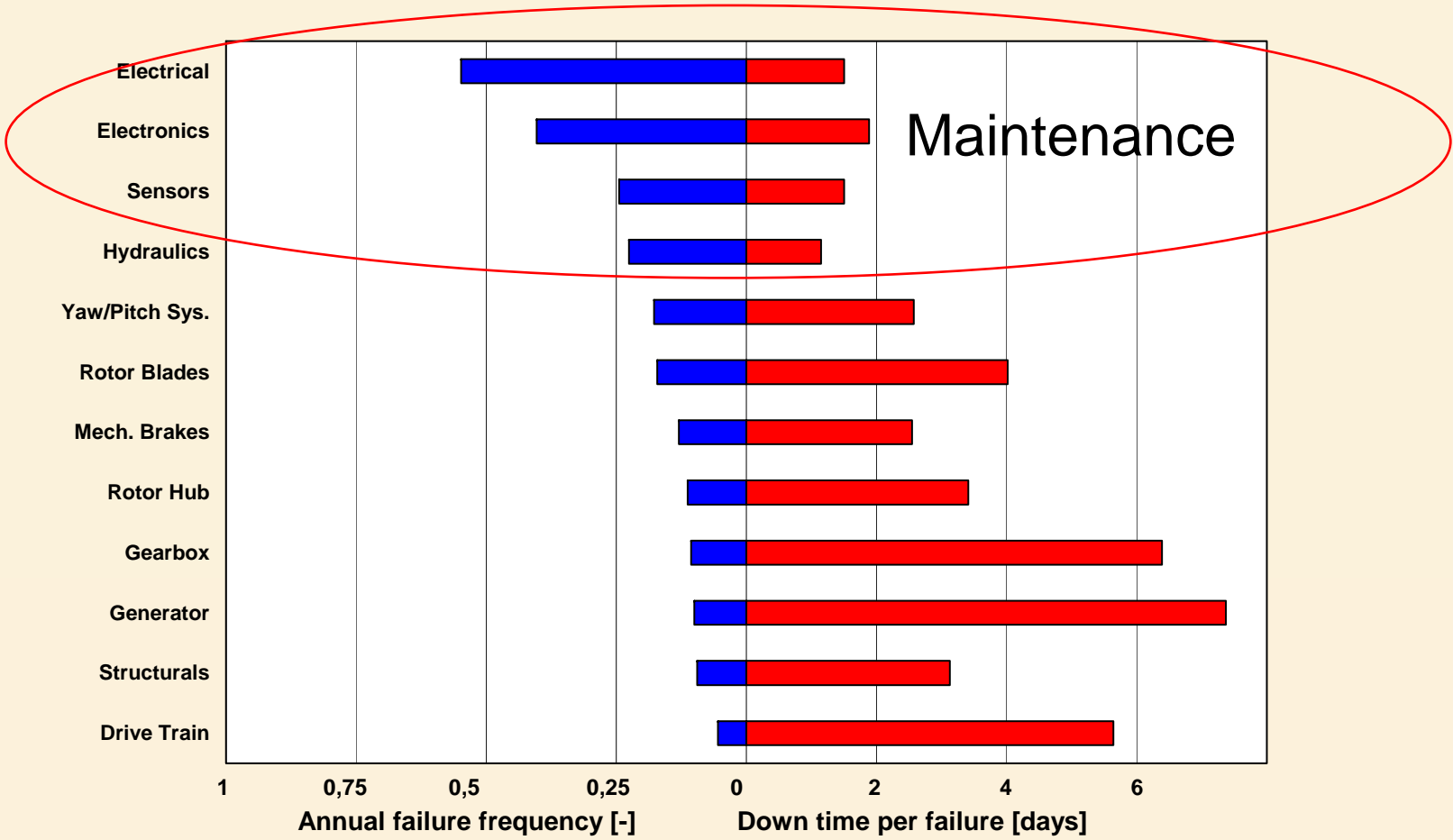
Post Wty. Maintenance Cost



- **Unscheduled minor maintenance highly variable by site / model.**
- **Budget figure meant to refer to minor recurring small part replacement.**
- **Excludes major component repairs.**

Maintenance: key functions

- **Unscheduled extension of on-site service.**
- **Relies on parts inventory or readily available parts that can be replaced by on-site service team.**
- **Involves recurring outages of short duration due to minor parts.**
- **Is tracked as operating expense, not as capital replacement expense.**



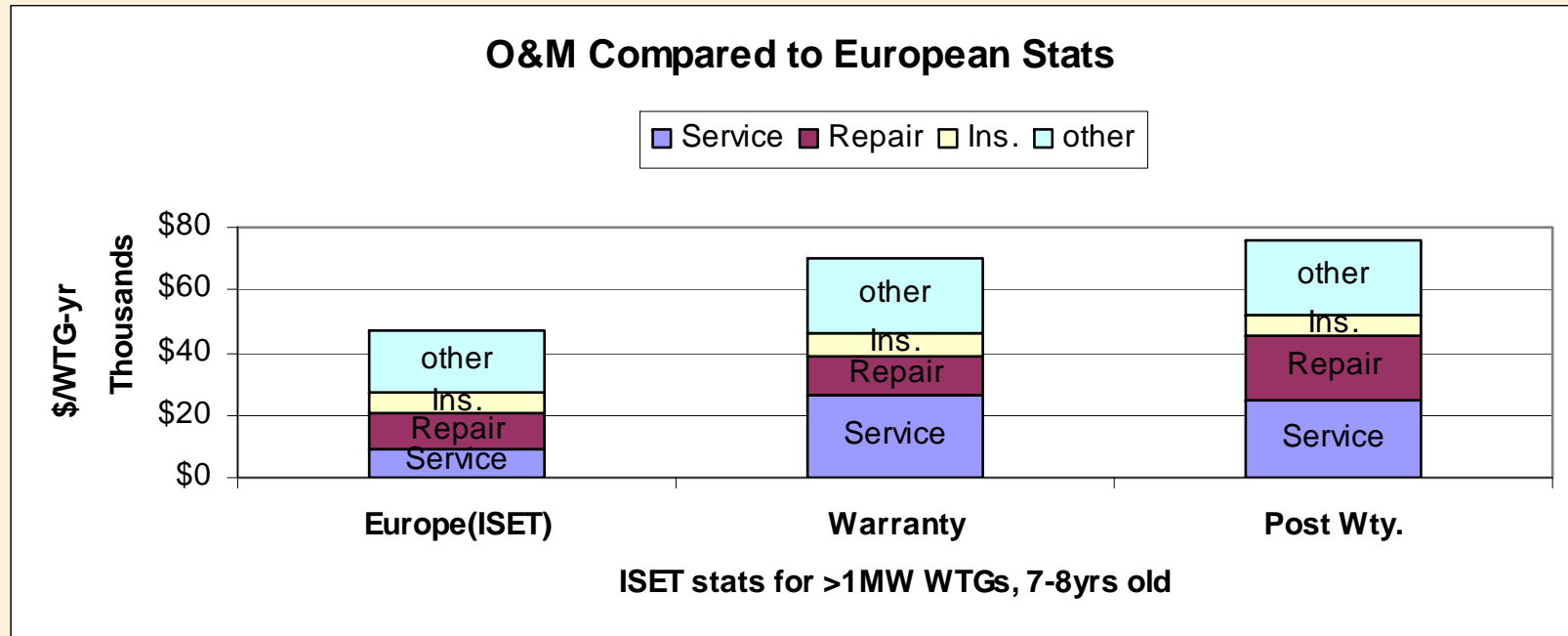
FAILURE FREQUENCY & DOWNTIME

Courtesy: B. Hahn, ISET: "Wind Energy Report Germany 2006" (draft)

Maintenance cost control:

- **Increase parts inventory to reduce outage time (hidden cost / rev. loss).**
- **Improve parts supply chain & 24/7 fix.**
- **Track inventory statistics (items needed per year).**
- **Early & preventative replacement.**
- **Develop staff competence / train.**

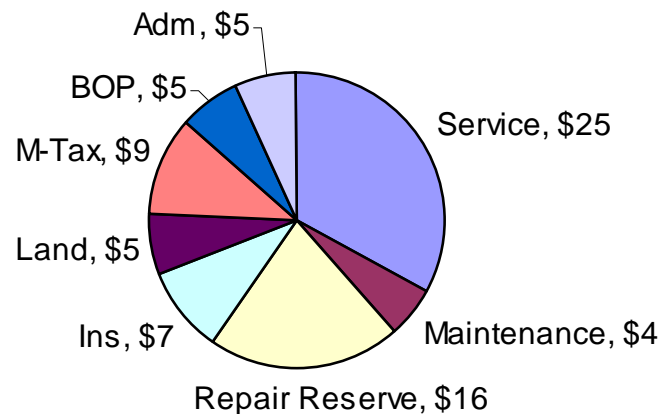
Maintenance Cost Check



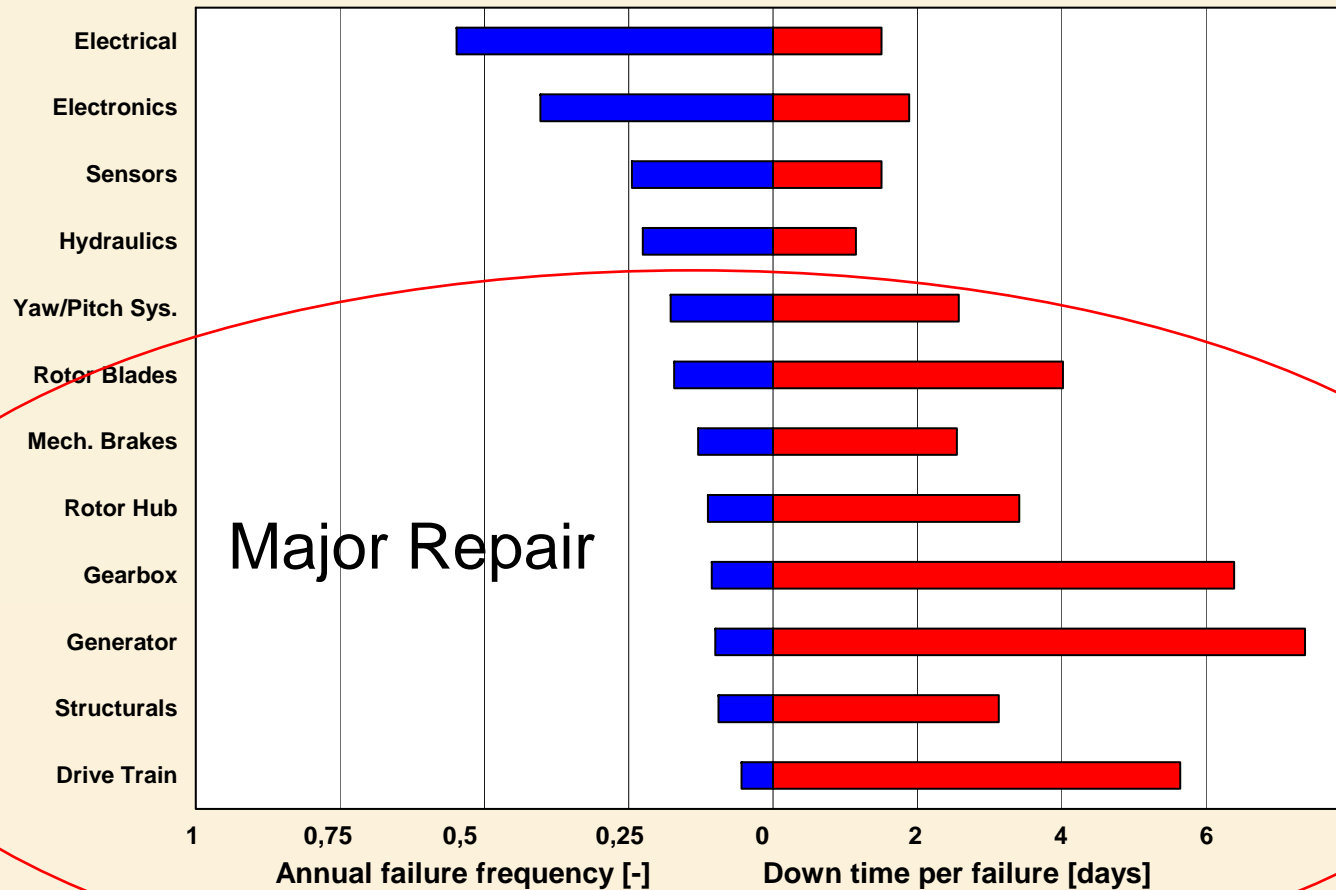
- **Europe (ISET) data does not split out maintenance. Not useful b/c \$4,000 mtnc. is only part of \$11,250 mtnc.+ repair figure.**
- **Need to use bottom up costing for verification (future topic).**

Post wty. Repair Reserve

Post O&M - \$(000)/WTG-yr



- **Planned or unplanned major repairs.**
- **Highly variable by site / model / age.**
- **Best to track as Capital Account – Repair Reserve.**
- **Expected to occur only a few times during 20 year life.**



Major Repair

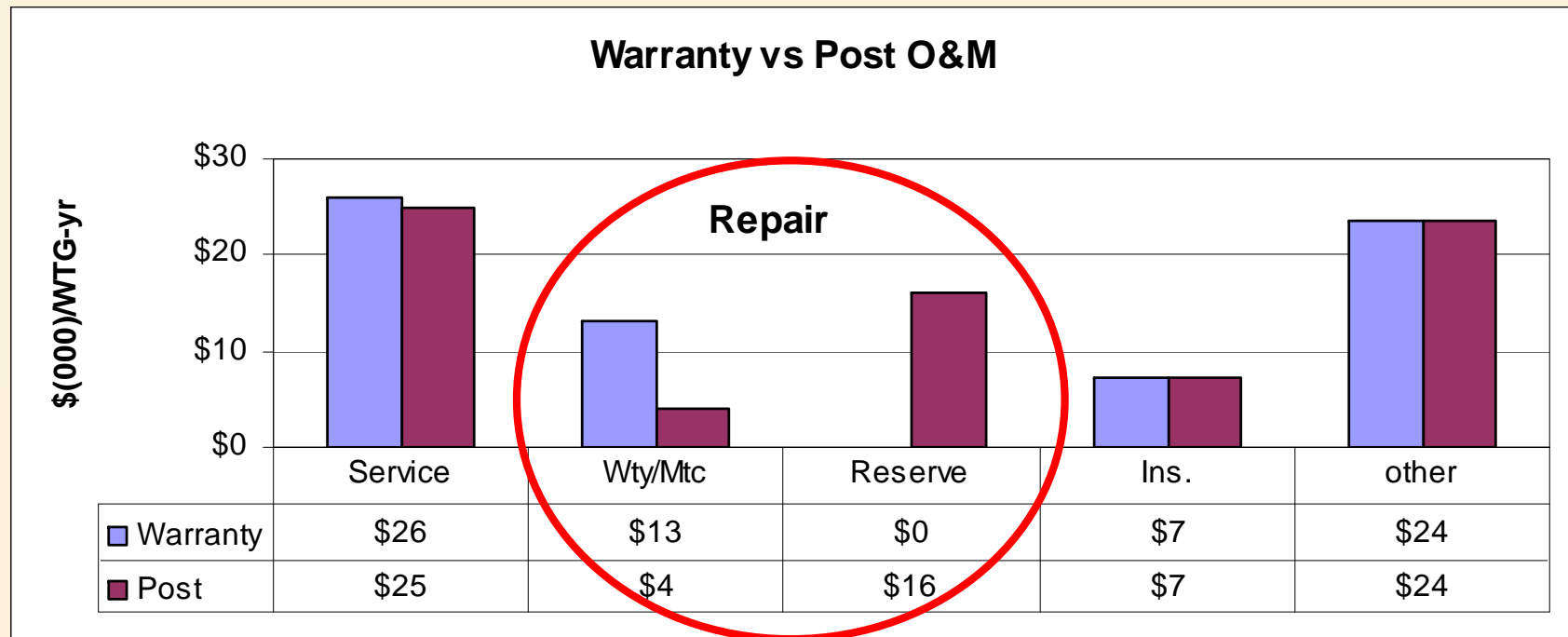
FAILURE FREQUENCY & DOWNTIME

Courtesy: B. Hahn, ISET: "Wind Energy Report Germany 2006" (draft)

Repair Reserve Contribution

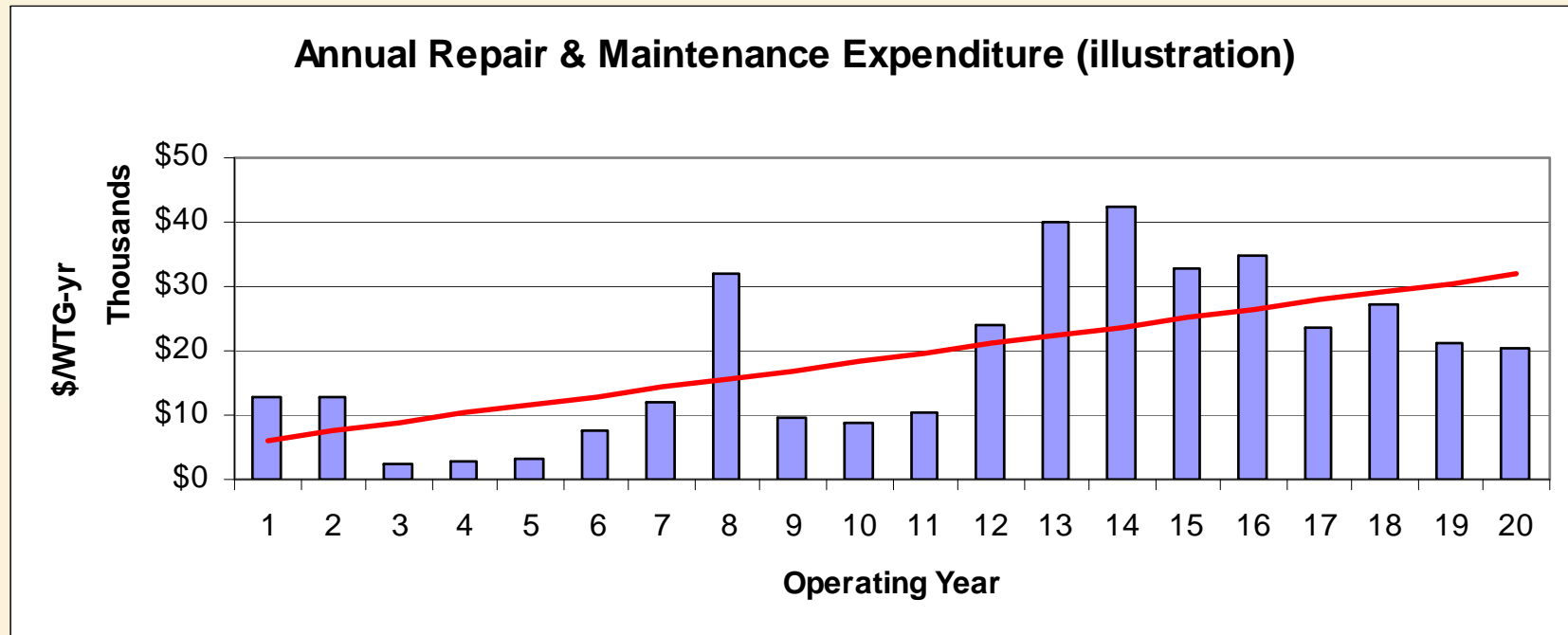
- **Depends greatly on site & model.**
- **Highly uncertain, little data available.**
- **May not know for many years what actual cost is for a specific site / model / age.**
- **Funds best held in a capital reserve, not in an annual operating expense account.**

Wty. Vs. Post Comparison



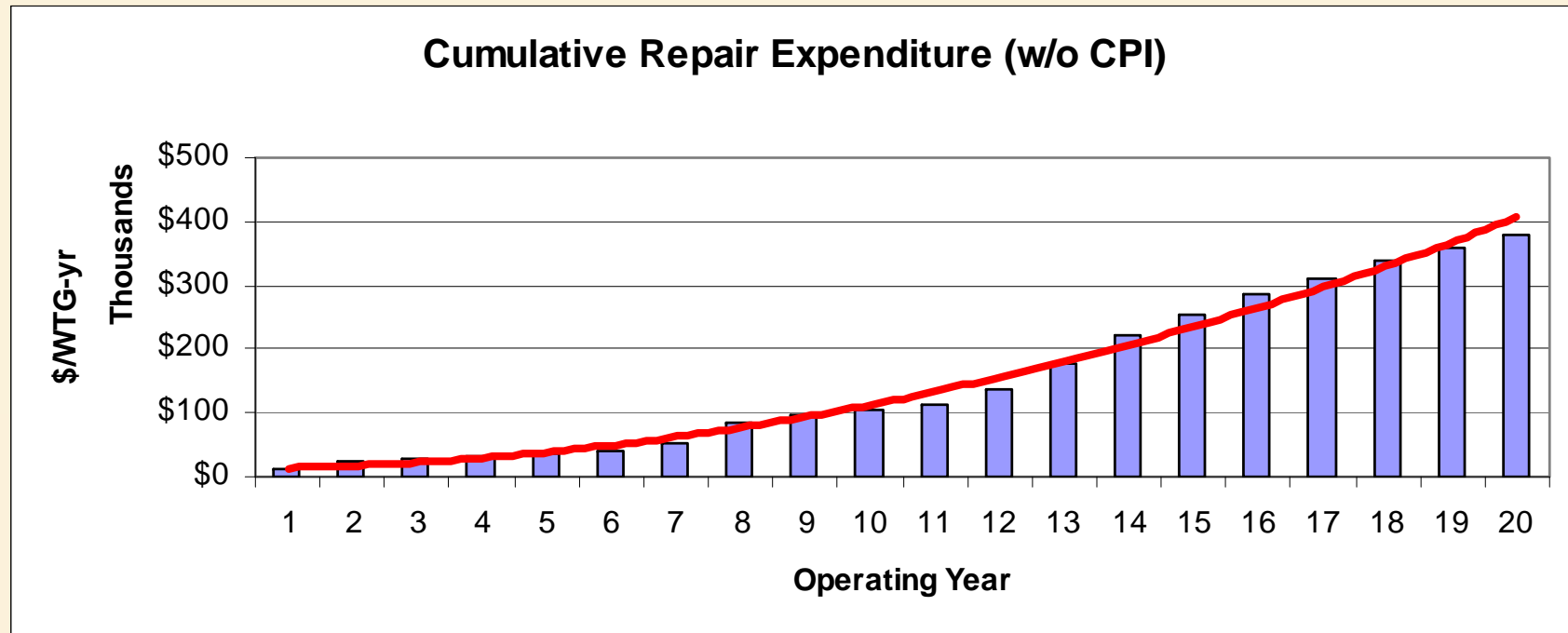
- **Maintenance is the expensed portion (recurring annually), Reserve is the capital portion.**
- **Mtnc. + Reserve = \$20,000/WTG-yr.**

Variable Annual Repair Costs



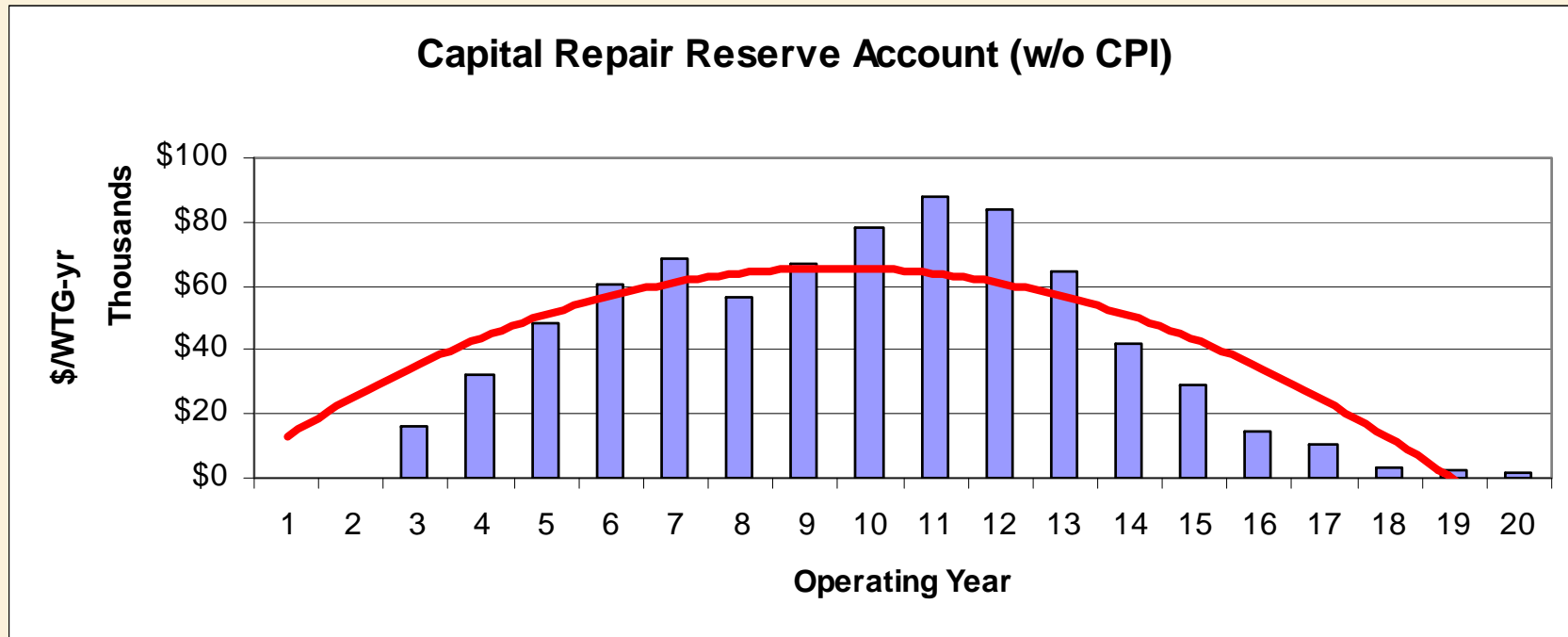
- While unscheduled minor maintenance is expected to remain fairly constant, major repair will occur in intervals and increase in cost with age.

Total life cycle cost



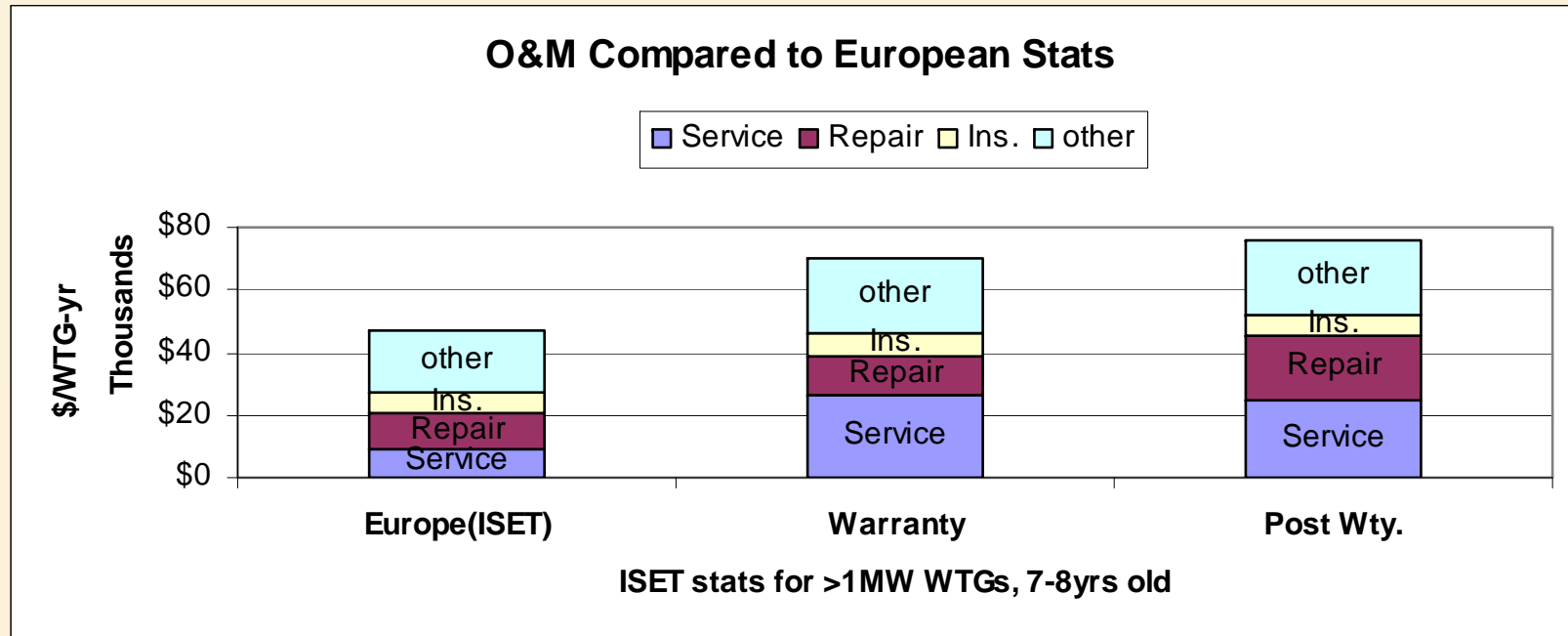
- **The operating goal is to minimize the cumulative total through preventative maintenance, early detection, reduction of outage times, etc.**
- **Small expenditure now may save big later.**

Capital Account



- **Purpose of the capital account is to ensure that the cost has been budgeted and the funds are available, regardless of the year in which the repair occurs.**
- **In early years, repairs are less than \$16,000/WTG-yr, excess is saved. In later years the reverse happens.**

Repair Reserve cost check

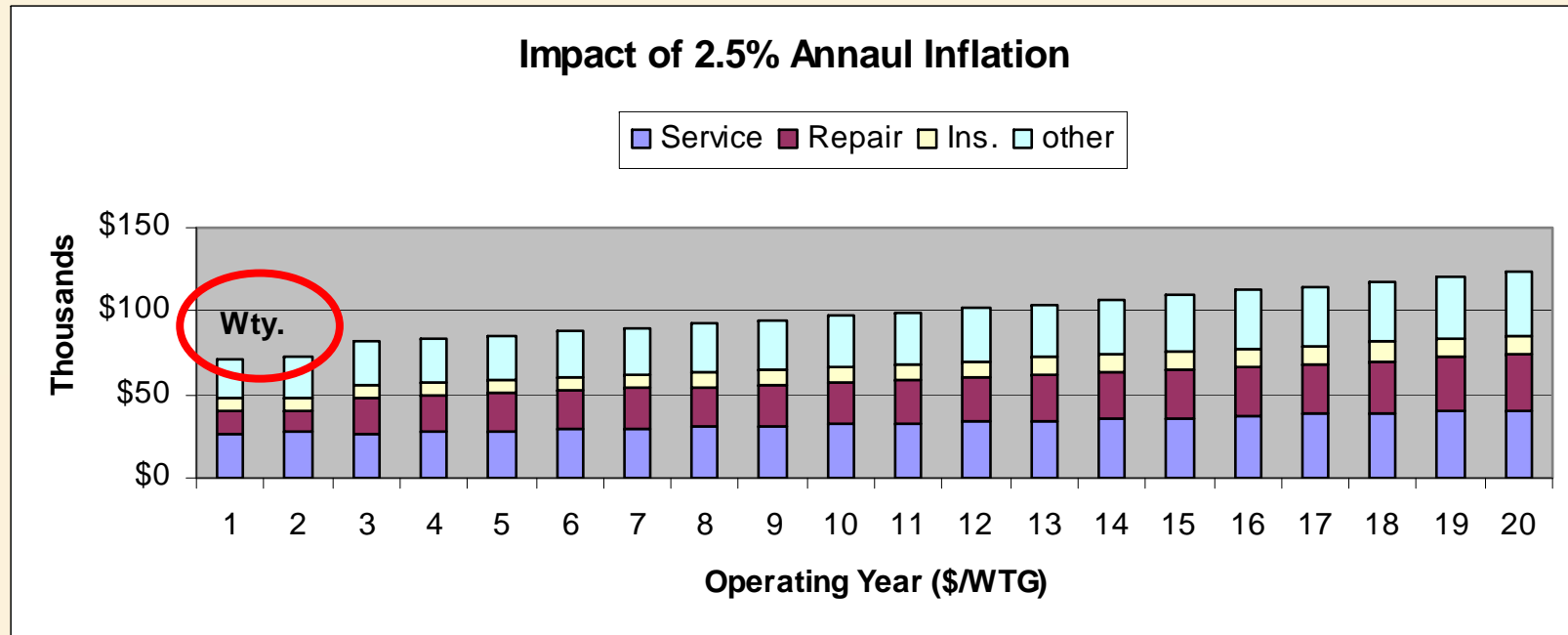


- **Combined mtnc. (\$4,000) plus reserve (\$16,000) is much larger than \$11,250 for 7-9 year old turbines in Europe (ISET).**

Sizing of Capital Reserve

- **Extremely difficult to validate.**
- **Should be done based on site characteristics (eg. turbulence, shear), model (eg. failure history, component analysis).**
- **Highly dependent on preventative maintenance and monitoring.**

Accounting for Inflation



- **Budgets can be inflation project forward by assuming inflation rate.**
- **Parts and labour costs may move differently than inflation.**

Conclusions

- **Limited data available for budgeting.**
- **Warranty / OEM quotes vary widely and may not be cost based.**
- **Conservative budget method outlined above.**
 - **Allows for cost saving in Service and Maintenance.**
 - **Has to be tailored for site/model/age of facility.**
- **Major repair best managed as life cycle capital cost.**
 - **Manage costs by preventative maintenance and condition monitoring.**
 - **Major repair cost difficult to est. / dep. On site/model/age.**
- **Use of capital reserve account is recommended for major and infrequent repairs.**
- **Inflation assumption can be used to project future years.**



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